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OPTICAL GROUP NORWALK, CONNECTICUT

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SYSTEM NO. 1
FINAL REPORT

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SUMMARY

This document represents the Final Report on GLOW System I and includes the installation and integration of the system at White Sands Missile Range, New Mexico.

Salient characteristics of prime equipment are described in detail; a complete bibliography, included at the rear of this report, encompasses all major reports and study phases of the GLOW effort.

Illustrations are used freely to support the text and bring the GLOW System into sharper focus. In addition, appendices are included at the end of this document as supplementary material in the operation of the GLOW System.

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INTRODUCTION

On March 26, 1963, The Perkin-Elmer Corporation, Electro-Optical Division, Norwalk, Conn., received a contract, No. DA-19-020-AMC-0144(Z), U.S. Army Missile Command, Redstone Arsenal, Huntsville, Alabama, for a two months' study program to establish parameters, block diagrams, and specifications for the Optical Reentry Instrumentation System for Project GLOW.

The overall program objectives are:

1. Determination of absolute spectral radiation emitted by various reentry vehicles of various configurations, compositions, and trajectories.

2. Continuation and extension of the measurements leading to recognition of optical reentry signatures needed in the development of detection and discrimination theory, sensors and systems.

3. Advancement in methods and techniques for interpretation of radiometric measurements.

4. Evaluation of the effectiveness of optical penetration aids.

5. To provide an accurate tracking platform for testing and evaluation of experimental optical instrumentation.

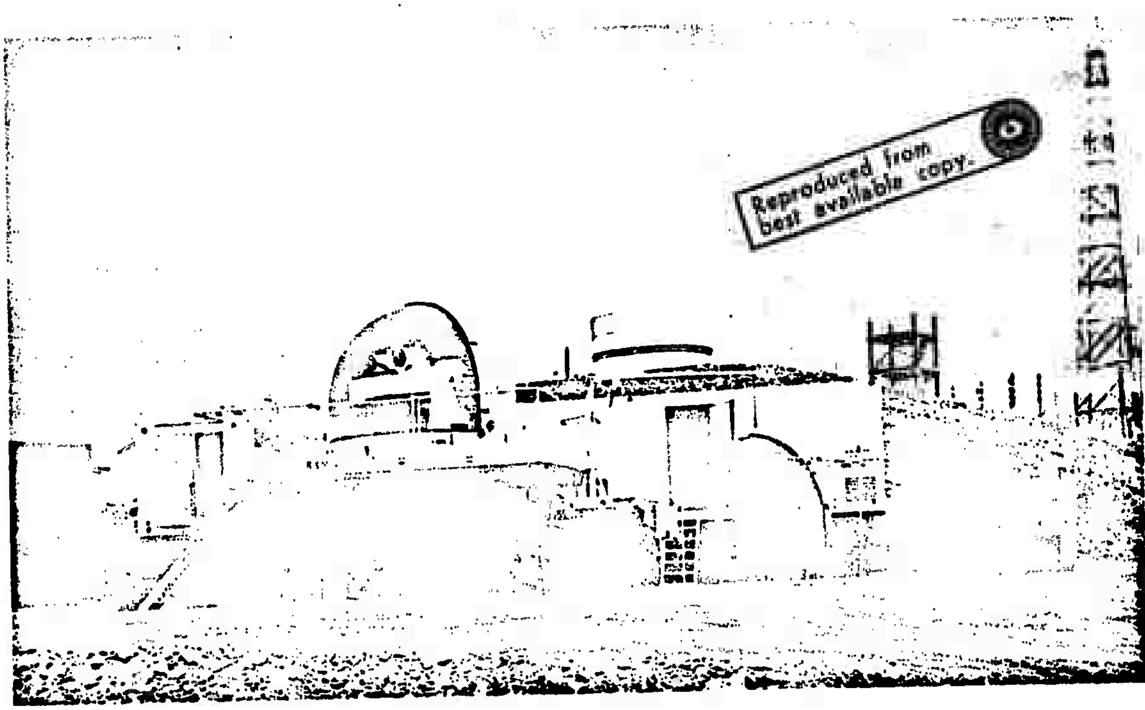
The study program for GLOW resulted in Engineering Report No. 7387, "Study Report for WSMR Optical Reentry Instrumentation System - Project GLOW", dated 15 July 1963.

Contract No. DA-19-020-AMC-0265(Z) provided for the design and fabrication of two (2) GLOW systems.

This program culminated in the installation and integration of one (1) system at the White Sands Missile Range, New Mexico (Contract No. DA-19-020-AMC-11992(Z), and one (1) at Kwajalein Test Site, Marshall Trust Territory (Contract No. DA-19-020-AMC-0265(Z).

The completed system involved studies and solutions of environmental factors and sites, interfacing of newly-designed components and government furnished equipment and facilities, and transportation preparation to the requested installation sites.

Furthermore, it involved the human engineering factors of specifying consoles, displays, and controls that would promote rapid and correct decisions by the operating crew during critical reentry periods.



GLOW Optical Reentry Instrumentation System, Salinas Peak, WSMR Installation

SECTION I

SYSTEM DESCRIPTION

1.1 OVERALL DESCRIPTION

The GLOW Optical Reentry Instrumentation System is designed to obtain data on the absolute spectral emissions of reentry bodies of various configurations, compositions, and trajectories. The GLOW system, which comprises data gathering and processing equipment, provides a high degree of accuracy, flexibility, and mobility. The three major units comprising the GLOW system are: A modified Nike-Ajax radar antenna pedestal equipped with optical data gathering instruments; a 34-foot semi-trailer instrumentation van containing an operator's console, instrument controls, and digital data handling and recording equipment; and a 28-foot semi-trailer utility van containing a B-50 manual sighting station, a dark room, and storage and maintenance facilities. The GLOW system installation at Salinas Peak on the White Sands Missile Range (WSMR), New Mexico, is shown in figure 1-1.

The heart of the GLOW system is the modified Nike-Ajax radar antenna pedestal and its associated servo system which supports and points all the data gathering instruments. The modified pedestal (referred to as GLOW mount) can receive its pointing commands from various remote or on-site devices, such as range radar, infrared or visible trackers, television trackers, a stiff stick aided tracking system, and manned sighting stations. Originally, the GLOW mount at Salinas Peak contained a vidicon television camera for visual observation of the reentry vehicle (R/V), two dual channel radiometers for nighttime reentry measurements, and a boresight camera for photography of the R/V. Later in the program a Mithras infrared autotracker and a Dalmo-Victor AC radiometer were added. When the GLOW system was transferred from Salinas Peak to Sole Site, located on the desert floor of WSMR, the vidicon television camera was replaced by an image orthicon television camera system with associated Bendix tracking gates.

A protective cover is supplied with the GLOW mount to provide weather protection for the platform instruments (see figure 1-1). The cover when installed on the mount, is designed to prevent the entrance of wind, dust, rain, snow and ice.

The cover is 9-feet in diameter and consists of four lower cylindrical sections, three upper spherical sections, and a mounting ring.

Quick disconnects and handles are provided for ease of assembly and disassembly. Figure 1-2 depicts the GLOW system assembly as installed at a typical site.

The control center of the GLOW system is the 34-foot long instrumentation van. The operator's station, instrument control equipment, pedestal servo system, data processing and recording equipment, and the sites electrical distribution system are all located in the instrumentation van. The GLOW mount, the 400 cps frequency converter, and the utility van are connected to the instrumentation van by cables which are shielded to reduce radio frequency interference (RFI). All input power lines to the instrumentation van contain RFI filters. Junction boxes, connector panels, and raceways are provided under removable sections of the van floor for the distribution of electrical signals and power to the instrument racks and out going cables. The instrumentation van also includes a heater/air conditioner unit.

The third major unit of the GLOW system is the 28-foot long utility van. This van contains a well equipped dark-room with cold storage for film, maintenance equipment, storage space, a B-50 manual sighting station, and a heater/air conditioner unit. The B-50 manual sighting station consists of a modified, manually operated, fire control alt-azimuth mount. Two sets of 1:1 and 25:1 synchros are driven as the mount is rotated in azimuth and elevation. In the B-50 manual sighting station mode of operation, the GLOW mount is slaved to the output of these synchros and thus is positioned by the B-50 mount. In addition to the three major units, the GLOW system includes a 60 to 4000 cps frequency converter, an optical calibration collimator unit for calibration of infrared equipment, and a target board to check operation and boresight of pedestal mounted instruments.

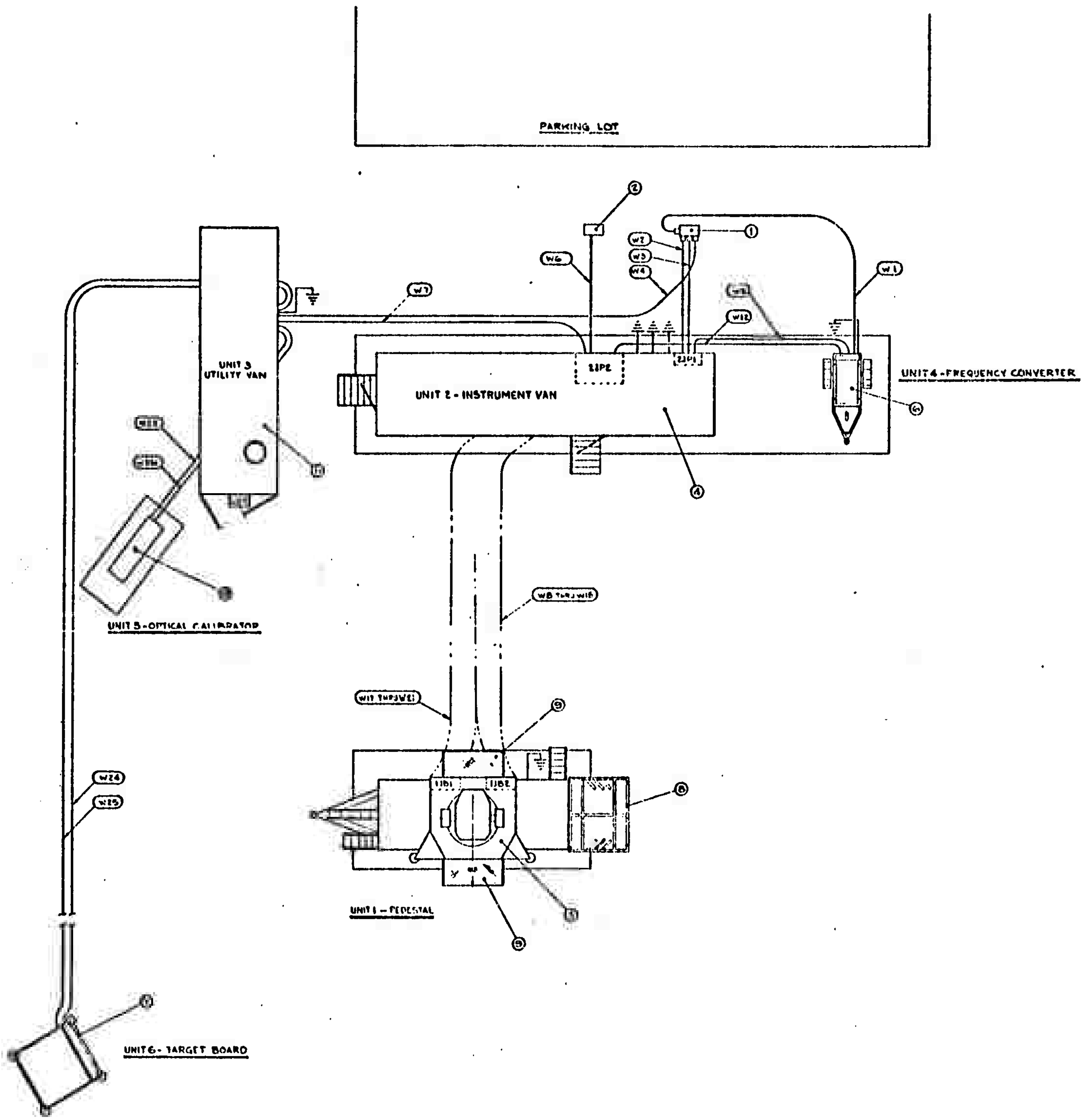


Figure 1-2. GLOW System Assembly

1.2 GLOW MOUNT

The GLOW mount is a government surplus Nike-Ajax radar antenna pedestal. With a modification program and a new servo system, a mount was developed having a static accuracy of 0.1 milliradian and a dynamic accuracy of 0.15 milliradian maximum lag error at constant velocities of 40 degrees/second in azimuth and 20 degrees/second in elevation. Peak error of the GLOW mount is 0.6 milliradian at azimuth accelerations of 20 degrees/second^2 and elevation accelerations of 10 degrees/second^2. The GLOW mount servo system is a sophisticated type II servo. It represents a marriage of the latest solid state input amplifiers, compensation networks, and integrators with the hard tube, magnetic amplifier velocity servo loop of the Nike-Ajax radar antenna pedestal. The result is a precision tracking platform that offers maximum adaptability to various types of input error devices. Figure 1-3 is a view of the modified Nike-Ajax radar antenna pedestal. Table 1-1 is a summary of system specifications for the modified Nike-Ajax radar antenna pedestal and associated system.

Figure 1-3. Modified Nike-Ajax Radar Antenna Pedestal (GLOW Mount)

Table 1-1 - Summary of System Specifications
Modified Nike-Ajax Radar Antenna Pedestal and System

	Azimuth	Elevation
Maximum Tracking Velocity	750 mrad/sec (43°/sec)	750 mrad/sec (43°/sec)
Maximum Slewing Velocity	840 mrad/sec (48°/sec)	950 mrad/sec (55°/sec)
Maximum Acceleration	800 mrad/sec^2 (45.8°/sec^2)	700 mrad/sec (39.3°/sec^2)
Static Pedestal Accuracy	0.1 mrad RMS	0.1 mrad RMS
Tracking Lag Error (at a constant rate of 40 deg/sec)	0.15 mrad	0.15 mrad
Peak Error (for acceleration of 10 deg/sec^2)	0.4 mrad	0.8 mrad
Open Loop Frequency Response (at unity gain)	4 cps	3.5 cps

Azimuth and elevation readout accuracy 17 bit encoders - 0.05 mrad

Instrument load capacity - 1200 lbs.

The basic modification in conversion of the Nike-Ajax radar antenna pedestal to an electro-optical instrumentation mount consisted of the removal of all non-essential components, fabrication and installation of new motors, re-cabling, and mount refurbishment. The non-essential components removed were the RF lens, RF pod, slip-ring assembly, and a number of RF electrical chassis such as the modulators, transmitters, and HV power supplies. An instrumentation platform, 55-3/4" x 42-1/2" x 10-1/2", fabricated of aluminum, was built up around the Nike-Ajax radar lens support ring. The platform can support 1200 pounds of instrumentation with negligible diaphragming or torsional bending. Instruments are mounted by bolting directly onto the platform faces, which can be drilled and tapped to suit.

Electrical limit stops enclosed in a special module are mounted in the 25-speed synchro pick-off hole. This module is designed to reverse the servo drive motors when a preset limit is reached. Presetting is achieved by adjustable split cams and microswitches. The module design also allows retention of the 25-speed synchro (for slaving purposes) and adds a second synchro which is used to activate a turn counter indicator. Mechanical limit stops are provided to limit rotation to ±2700 in azimuth. These stops consist of a spring buffer mounted on the yoke and two elbow stops located on the pedestal base. An electrical limit switch in the buffer cuts off mount power when the mechanical limits are actuated during mount operation, and when the electrical limits fail to function. Electrical and mechanical limit stops are provided to limit elevation. The electrical limits reverse the servo drive motors when they are actuated (either at -10° or 90°). An override switch permits the platform to be dumped, i.e., rotated through 180° elevation. The mechanical limit stops are at -10° and 190° and consist of a stop pin located on the elevation drive gear which strikes a spring buffer. These stops were reoriented during mount modification.

Azimuth and elevation mount positions are read out by means of a digital data system consisting of 17-bit shaft encoders and parallel-to-series converters (shift register). Figure 1-4 shows the azimuth encoder installation and figure 1-5 shows the elevation encoder installation.

A hydraulically operated crane is bolted on the aft platform of the Nike-Ajax trailer for handling the protective cover and heavy, bulky instruments being installed on the instrumentation platform. It can be rotated about its azimuth axis and locked in position to facilitate lifting instruments and spotting them over the platform. If desired, the crane can be removed and stored horizontally on the platform. Tie points on the trailer are used to secure the crane when not in use. (See figure 1-6.)

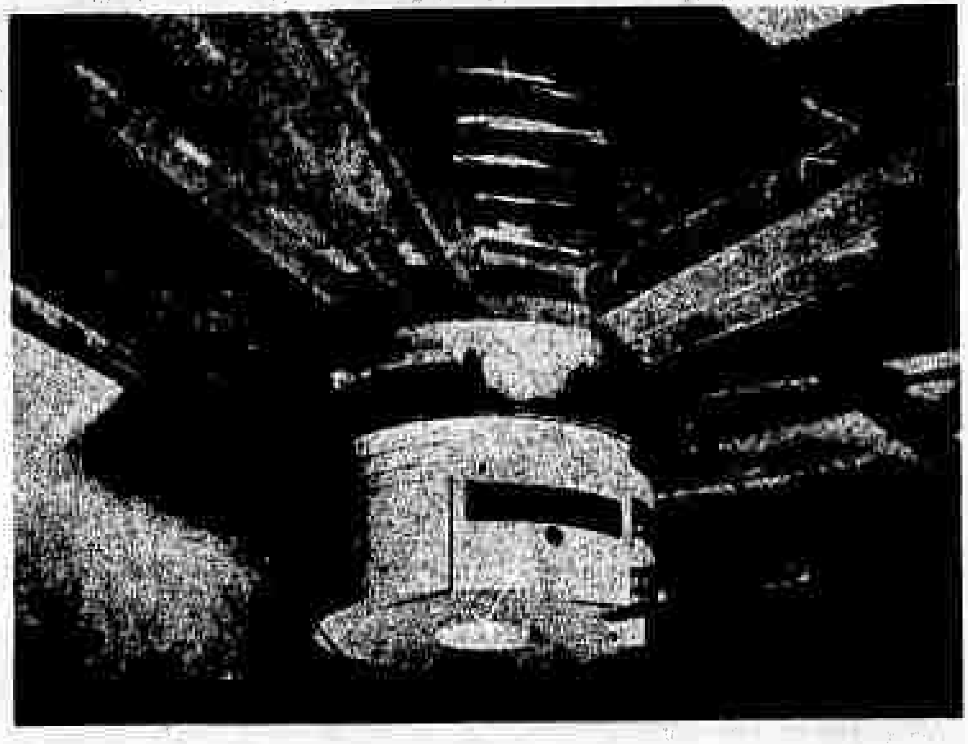


Figure 1-4. Azimuth Encoder Installation and Twist-Up Cable Assembly

Figure 1-5. Elevation Encoder Installation and Cable Loop

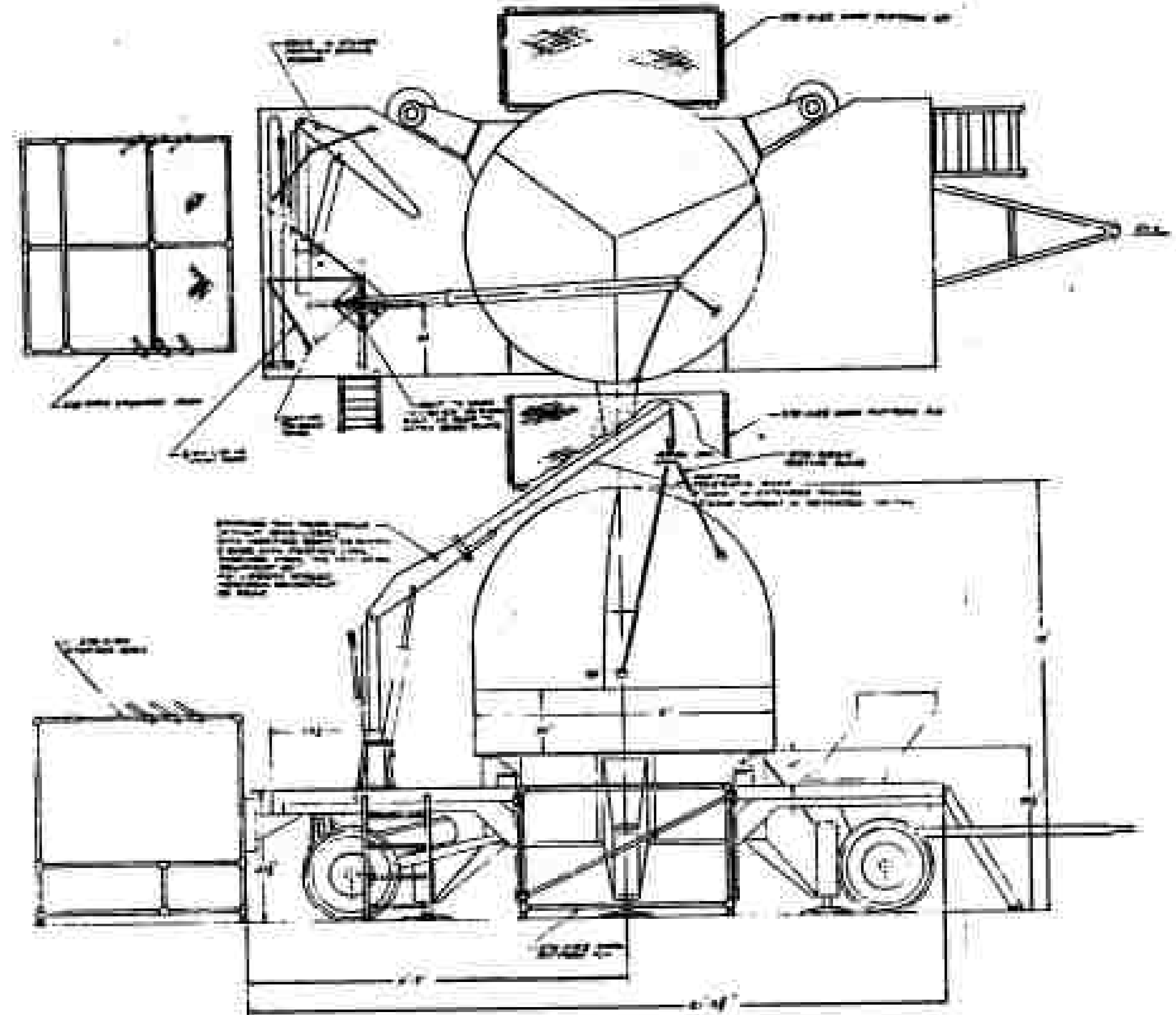


Figure 1-6. GLOW Mount Assen

At the time of installation the instrumentation configuration was as shown in figure 1-7. Two Perkin-Elmer dual-channel radiometers, with their cryogenics supply, are on top of the platform, while the bottom of the platform contains a 35mm boresight camera on the left and a vidicon television camera on the right. The unit between the cameras is a bracket with lead weights used to balance the pedestal.

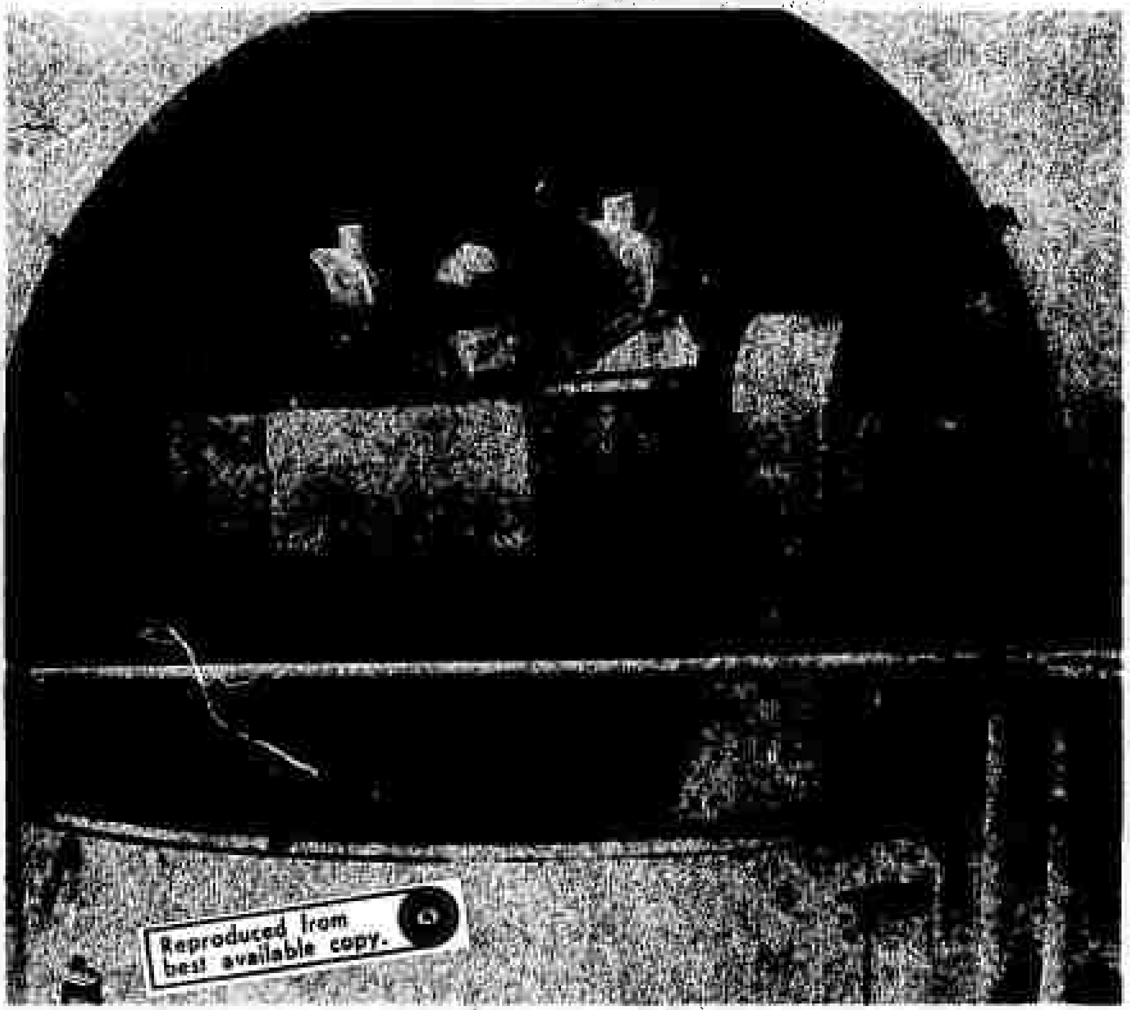


Figure 1-7. GLOW Mount with Instrumentation

1.2.1 Dual-Channel Radiometers

The dual-channel radiometer system serves as a primary reentry measurement instrument complex compatible with the Project GLOW Nike-Ajax tracking pedestal and digital data processing systems.

Design techniques were chosen to favor nighttime reentry measurements under tight tracking control, following early radar acquisition. Particular attention was directed to automatic control and monitoring of performance in real time, in measurement of rapidly fluctuated emissions spanning a wide dynamic range of radiant intensity. Modular flexibility in these instruments allows field substitution of alternate detector filters and field stops meeting the needs of other experiments.

Each dual channel radiometer system, shown pictorially in figure 1-8, incorporates:

1. Two 8 inch aperture dual-channel radiometer optical heads each with its independent Kinematic alignment base and main mounting plate structure.

2. One pedestal-mounted junction box serving as a cable interface, and buffer amplifiers required to raise sensitive signals to levels suitable for transmission through 100 foot cables to the instrumentation van.

3. One 5-liter capacity dual-feed liquid nitrogen dewar and feed system. This assemblage mounts in juxtaposition to the dual-channel radiometer optical heads and incorporates a bracket arrangement for damped pendulous suspension of the dewar.

4. Independent control electronic units, one for each of the four detector channels, rack-installed in the instrumentation van. Each dual-channel radiometer electronic subsystem incorporates a dual beam cathode ray oscilloscope and a monitor panel for easy access and observation of key signal points within the system. Control electronic unit outputs are transmitted to the GLOW Digital Data Handling subsystem for further signal conditioning and tape recording.

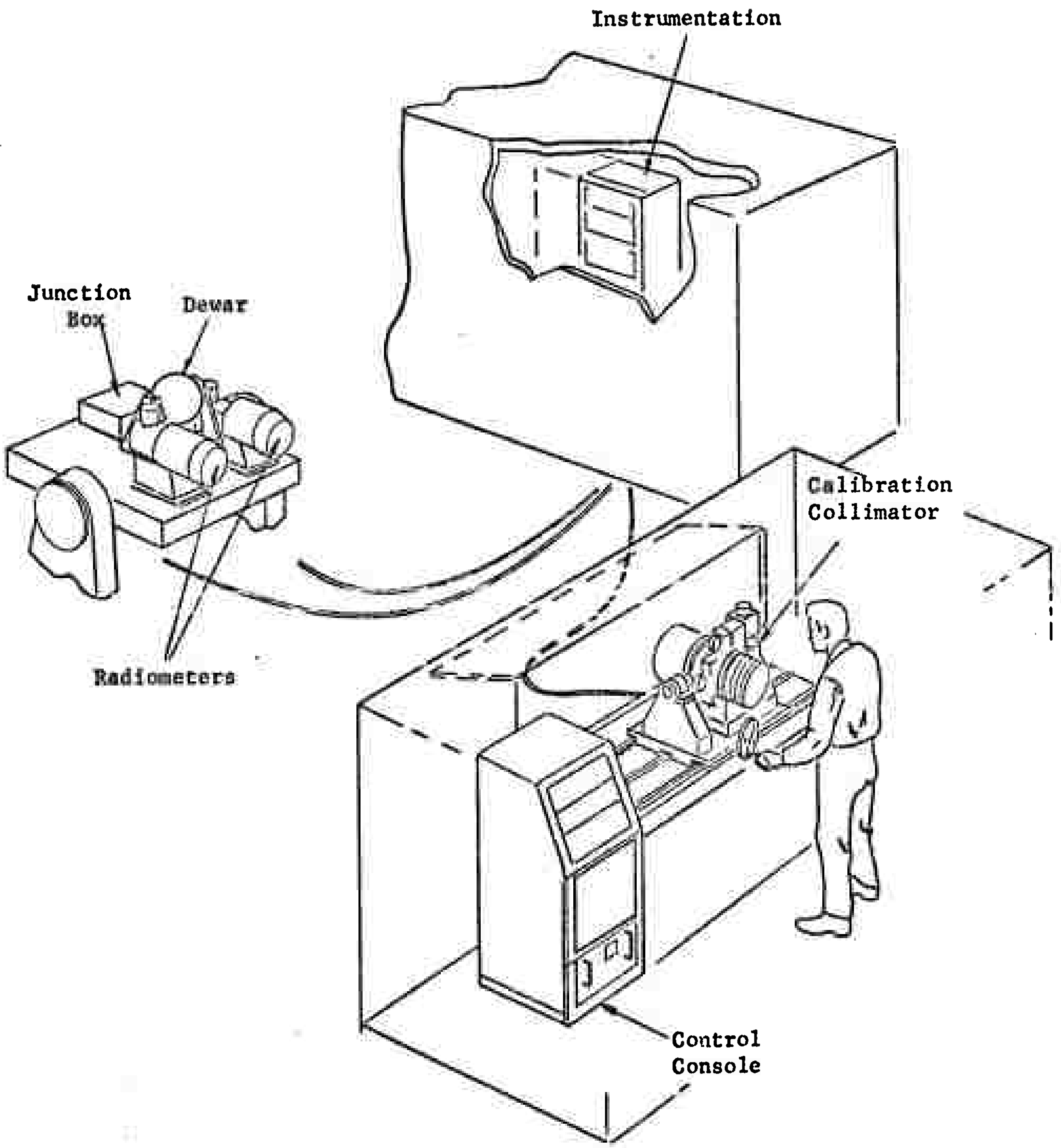


Figure 1-8. Dual Channel Radiometer System

The dual-channel radiometer, shown in figure 1-9, employs an ambient temperature lead sulphide (PbS) detector for sensing in the spectral region from nominally 5,000A to 2.7 microns, and a liquid nitrogen cooled Indium Antimonide (InSb) dewar detector for coverage in the wavelength range of 2.8 to 5.5 microns. Independent optical paths to each of these detectors are established by a dichroic beamsplitter, each path incorporating a 4-position remote controlled filter wheel. With the exception of the dielectrically coated filter elements, the radiometer optical path is all-reflected, thereby permitting application of this instrument with suitable change in detectors over a spectral range extending through the visible to beyond 20 microns.

In order to cope with anticipated strong electromagnetic radiation fields, the instrument incorporates a number of radio frequency interference (RFI) immunization techniques, such as RF gasketing, front aperture honeycomb, and RF filter elements.

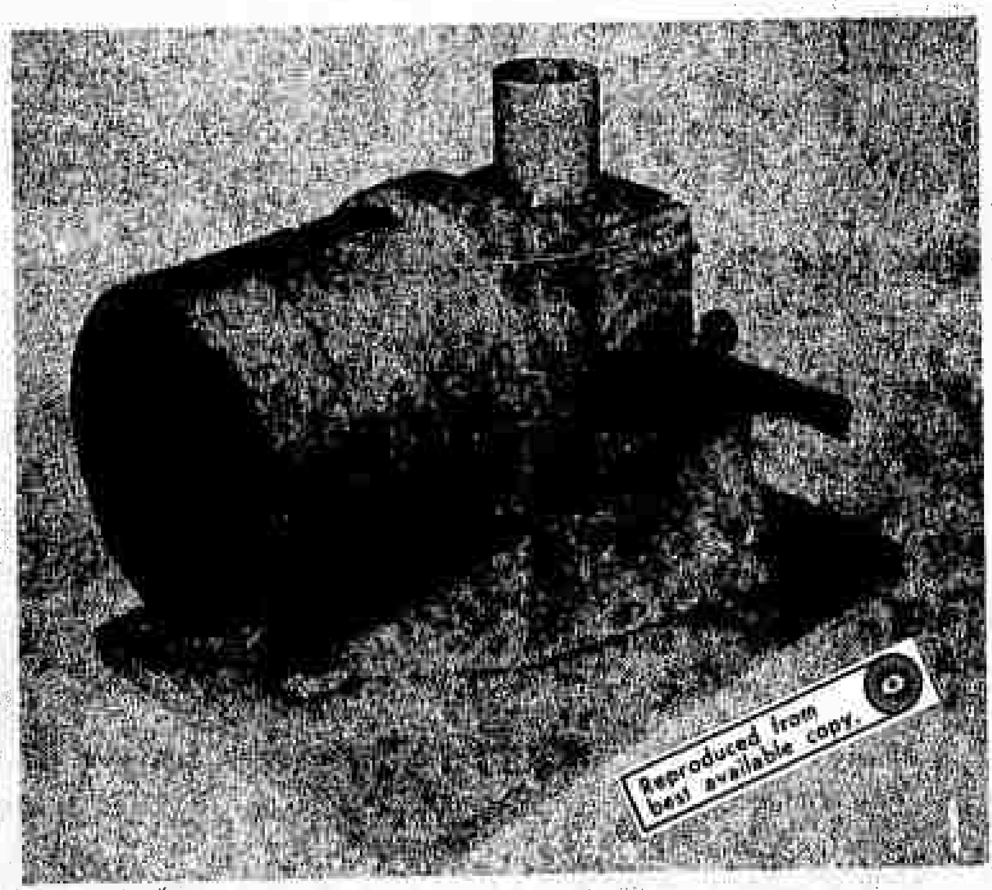


Figure 1-9. Dual Channel Radiometer

The collector system of the dual channel radiometer, a 20 cm aperture, 52 cm focal length Dall-Kirkham design, provides on-axis image quality (90 percent energy) better than 60 microns diameter.

The instrument field of view, 4.0 milliradian diameter, is defined by a suitable aperture stop mounted in the modularized "generator block" assembly. This assembly modulates collected radiation at a 320 cps rate, referencing to an ambient temperature coaxial cavity in alternate half cycles, and includes an independent low speed shutter function (1.90 second exposure, 0.10 second blanking) used for signal control and calibration.

Modulated radiation diverging from the field stop is split by a dichroic filter element in close proximity, with radiation from nominally 0.45 - 2.70 micron reflected to the PbS detector channel, and 2.80 - 8.0 micron energy transmitted in the InSb detector path.

A four-position remote indexable filter wheel in each of the paths permits narrower spectral band definition before collection and focusing of the energy on the detector surfaces.

An all-reflective ellipsoid-planar transfer system serves this function, providing a 3.5X demagnified image of the field stop at the detector plane. This high power transfer system permits use of substitutable pre-aligned detector assemblies, 0.80mm active area diameter, with significant enhancement of instrument sensitivity.

This instrument is furnished with an integrated Kinematic (ball and flat) alignment base and heavy duty mounting plate, designed for precision setting of line of sight to better than 5 arc seconds over a range of 2.0° about elevation and azimuth axes. A removable focal plane microscope assembly (23X) pre-aligned to the field stop center simplifies the boresighting procedure, and assures precise alignment to remote reference targets.

The liquid nitrogen storage and transfer system (see figure 1-10) is mounted in juxtaposition to the two infrared radiometers on the instrumentation platform. A pendulous suspension assembly mounts the spherical dewar. The pendulous mount is employed to maintain dewar attitude vertical under anticipated tracking platform motions and orientation.

Transfer of the nitrogen through independent flexible polyvinyl lines in droplet form (Leidenfrost transfer) supplies coolant to the Indium Antimonide detectors in each instrument. Liquid flow is controlled by solenoids located in each return line in the dewar. Fixed orifices establish optimum flow rate.

The electronics for the dual channel radiometer consists of two independent detector preamplifier modules integral with the radiometer optical head, a single master junction box containing booster and cable driving amplifiers, functionally independent processing control, and monitoring electronics contained in the instrumentation van.

A common monitor panel and oscilloscope facilitate monitoring selected significant signal points within the system.

The electronics operates as follows (see figure 1-11).

1.2.1.1 Signal Channels

The signal channel converts received energy incident upon the detector to electrical signals suitable for recording. Channel No. 1 is furnished with an uncooled biased lead sulfide (PbS) detector and Channel No. 2 with a liquid nitrogen cooled Indium Antimonide (InSb) dewar detector operating in the photovoltaic mode. Except for a low noise input stage in the Indium Antimonide preamplifier, both signal channels are the same.

In the operational mode, radiation on the detectors is double modulated; a four blade chopper giving rise to the fundamental 320 cps carrier frequency, and a rotary shutter in the optical path blocking the modulated signal for a 115 millisecond period every two seconds. During the open period, target radiation changes appear as an amplitude modulation of the 320 cps carrier.

The detector signal is applied to a 320 cps stagger tuned preamplifier, maximally flat, with 3db points at nominally 270 and 370 cps to yield a maximum 50 cps information bandpass. The preamplifier module provides means for calibration injection in series with the detector and voltage applied gain control operating on the transistor h and β parameters. Maximum preamplifier gains are chosen to elevate detector and amplifier generated noise to a nominal 5.0 millivolt rms level for transmission through the long cable lines. Both detectors are transformer coupled to their respective amplifiers to effect a desirable impedance match. In addition, however, the low primary resistance of the input transformer presents an effective dc short circuit to the InSb detector, negating back bias effects, and maintaining relatively constant response under a varying quiescent radiation level. A very low noise stage following the InSb transformer results in an overall preamplifier noise figure of about 1.0 db at 320 cps.

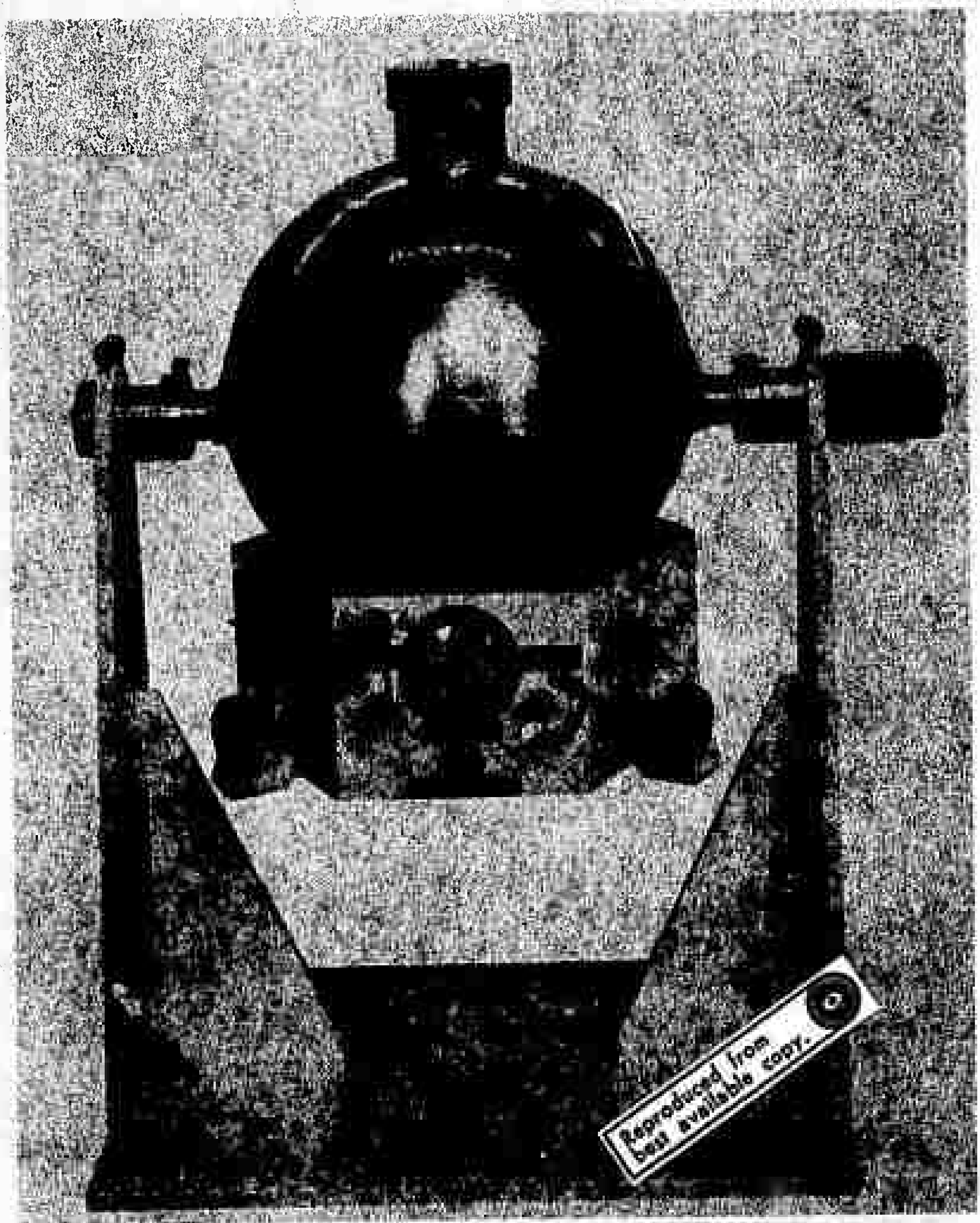


Figure 1-10. Liquid Nitrogen Storage System

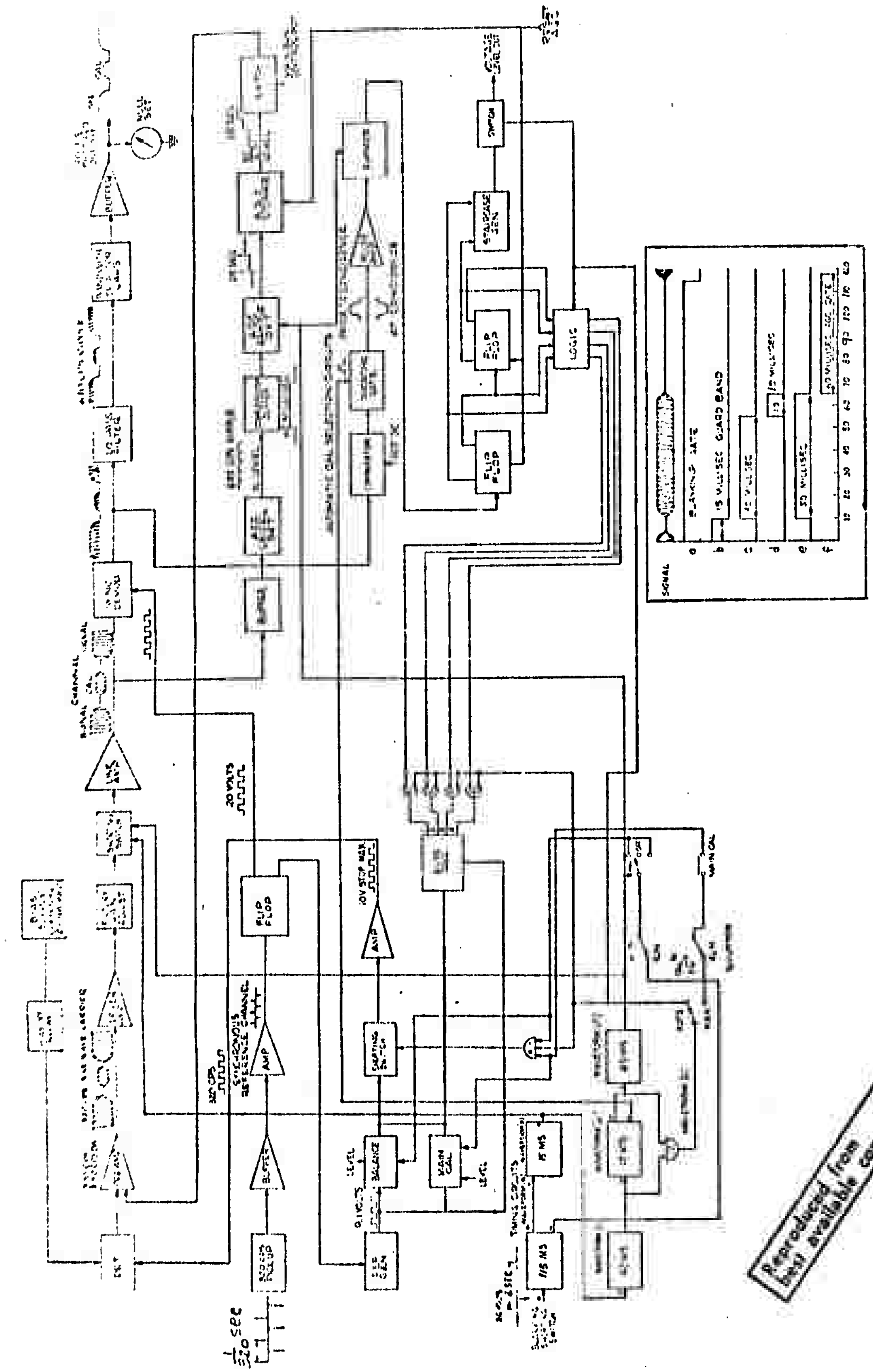


Figure 1-11a

Figure 1-11. Electronics Subsystem - Block Diagram

TABLE 1-2. SUMMARY - INSTRUMENT PARAMETERS

GLOW INSTRUMENTATION MATRIX - PRIMARY INSTRUMENTS

INSTRUMENT	f/NO.	COLLECTING APERTURE	FOCAL LENGTH	SENSOR	FILTER	FIELD OF VIEW	SPECTRAL REGION	RECORDING MEDIUM	TIMING
DUAL CHANNEL RADIOMETER "A"	2.7	8"	52"	CHANNEL # 1 PBS	1. 0.8-1.3 2. 1.45-1.7 3. 2.0-2.5 4. 0.3-8.0	4mr	0.8 0.8 to 2.7	MAGNETIC TAPE & OSCILLOGRAPH RECORDER	IRIG C
				CHANNEL #2 1NSB	1. 3.5-3.8 2. 3.75-4.4 3. 4.5-5.1 4. 0.3-8.0	4mr	1.0 to 5.5		IRIG C
DUAL CHANNEL RADIOMETER "B"	2.7	8"	52"	CHANNEL # 1 PBS	1. 0.8-1.3 2. 1.45-1.7 3. 2.0-2.5 4. 0.3-8.0	4mr	0.5 to 2.5	MAGNETIC TAPE & OSCILLOGRAPH RECORDER	IRIG C
				CHANNEL #2 1NSB	1. 3.5-3.8 2. 3.75-4.4 3. 4.5-5.1 4. 0.3-8.0	4mr	1.0 to 5.5		IRIG C
BORESIGHT CAMERA 35mm FLIGHT RESEARCH	8.0	5"	40"	KODAK FILM 2475	As Required	1 x 1.3°	Visible	35mm FILM	IRIG B
VIDICON TELEVISION	4	5"	20		N/A	2" x 2"	Visible	N/A	N/A

NOTE: GLOW System Contains Two Dual Channel Radiometers

Signal outputs from the preamplifiers are connected through 10 foot cables to impedance transforming line amplifiers incorporated in the Junction Box, preparatory to transmission through the 100 foot main cable to the instrumentation van electronics unit. Additional amplification in the van electronics increases signal level to nominally 5.0 volt rms for application to an internal synchronous demodulator and through output cables to signal conditioning circuits associated with the digital tape recording system.

The output of the solid state synchronous demodulator, a bi-polar full wave rectified signal,is applied to a ripple rejecting low pass filter, single time-constant R.C. bandwidth selection filter, and output buffer amplifier. This filtered and buffered signal is monitored by a zero-center front panel meter in each channel (±5.0 Vdc full scale) and made available for detail observation and recording from easy access front terminals on the monitor panel and through the output cable.

1.2.1.2 Synchronous Reference Channel

This channel serves to provide the in-phase synchronous excitation to the demodulator and the calibration reference and balance levels to the preamplifier. Each signal channel has its own independent synchronous reference channel.

The synchronous reference signal is generated by a magnetic pickoff located in proximity to the 80 rps steel chopper blade. The angular position of the pickoff is variable with the system in operation, for rapid coincident phasing between the detector fundamental signal, and the synchronous demodulator excitation. The magnetic sensor output, a train of alternating bi-polar pulses is fed through buffer amplifiers in the junction box to drive the 100 foot cable. Further amplification in the instrumentation van electronics provides drive to a transformer-steering diode trigger circuit for excitation of the 320 cps flip-flop. The resultant square wave is complementary buffered to drive the synchronous demodulator, the calibration and null balance circuits, and made available through the output cable for signal conditioning preparatory to digital tape recording.

1.2.1.3 Calibration and Null Balance Generators

The output of the calibration and null balance generator is a 9.1 volt, 1 percent stabilized 320 cps square wave signal derived from driving a solid state switch alternately between a 9.1 volt temperature stabilized zener diode and ground. This output signal is transformer coupled to a resistor string, providing a precision bi-polar calibration level, and to a continuously variable 10 turn potentiometer to provide bi-polar null balance levels over a 1000 to 1 range.

NULL BALANCE

Channel No. 1 (PbS):	0-1000uv rms sine wave
Channel No. 2 (InSb):	0-10,000uv rms sine wave

CALIBRATION

Channel No. 1 (PbS):	10,100, 1000,10,000 v rms sine wave ± 2 percent
Channel No. 2 (InSb):	1,10, 100, 1000 v rms sine wave ± 2 percent

The calibration and null balance levels are switched through logic circuits to a common driver amplifier which feeds the preamplifier calibration input. This amplifier has its input shorted when balance and calibrate functions are not in use.

1.2.1.4 Timing Circuits (See figure 1-11a)

The timing circuits are common to both channels. This network incorporates five monostable multivibrators or "one-shots" functioning to generate the required pulses and gates used as inputs to the comparison and switching circuits. A commutator affixed to the rotary shutter drive closes just before the shutter blocks the energy input to the detector. This pulses the first monostable multivibrator generating the 115 millisecond blanking gate and an inverted blanking gate (balance gate) which removes the null balance level from the signal channels during this period. Initiation of the blanking gate triggers the second monostable multivibrator generating a 15 millisecond pulse used in a shorting switch in the signal channel. The trailing edge of the 15 millisecond pulse triggers the third monostable multivibrator generating a 40 millisecond pulse, which in turn triggers the fourth monostable multivibrator, generating a 10 millisecond pulse. The resultant pulse period sum produces the 50 millisecond calibration gate for injection of calibration level into the preamplifier. In addition, the 10 millisecond pulse is used to sample the calibrate level in the automatic calibration selection circuit. The trailing edge of the 10 millisecond pulse triggers the fifth monostable multivibrator that generates a 60 millisecond AGC gate which closes the AGC sample switch. The AGC pulse like the initial 15 millisecond pulse, closes the signal channel shorting switch thus eliminating spurious signals generated during this period.

1.2.1.5 Operational Modes

The Dual Channel Radiometer operates in either of two modes: Manual Gain Control (MGC) and Automatic Gain Control (AGC). Each channel contains independent circuitry to perform the following:

This Manual Gain Control mode is used primarily for system calibration, test, and set up preparatory to operation in the AGC mode. The gain is controlled manually with the ten turn gain potentiometer on the front panel.

In the Automatic Gain Control mode, which is the system operational mode during a reentry measurement, keyed AGC is employed to keep the rapidly increasing signal within the dynamic range of the system.

The presence of a signal will charge the AGC level detector, which senses peak signal. During the 115 millisecond blanking the AGC gate pulse closes a solid state switch which transfers the detected AGC level to the AGC storage circuit (Sample and Hold function). This fixes a new lower gain in the preamplifier for the subsequent two second measurement interval. As the source increases in intensity, the AGC detector output is further charged and periodically transferred to the storage circuit to reduce the preamplifier gain in steps. The AGC detector is designed with a relative short attach time (two keying sequences) and a very long discharge time, thus mitigating signal drop-out effects due to source obscuration by clouds, etc.

The AGC system is set up to handle a signal increase of ten to one during any two second measurement interval, and will take the system out of saturation arising from an initial input one thousand times greater than threshold in two keying sequences.

1.2.1.6 Automatic Calibrate Selection Circuits

In AGC mode the level of the 50 millisecond calibration carrier burst injected during the blanking period is automatically switched as a function of the changing signal channel gain. Four calibrate levels encompassing a range of 1000:1 in decade steps are available.

The automatically injected calibrate levels are the same as those indicated on the manual CAL LEVEL switch for respective channels. Depressing the AGC RESET button establishes maximum signal channel gain and sets up the minimum calibrate level. The output level during the calibration injection period is sampled every two seconds and applied to a comparator circuit: When the gain decreases to produce a calibrate output less than the comparator reference level (50 mv), a pulse is generated which triggers a counter, switching in the next higher calibrate level. This will appear in

the signal chain in the subsequent calibration period. The counter has a four level capability, switching the calibrate at each step, and retaining the maximum calibrate level until the AGC reset is depressed setting the selection circuits to their initial state.

1.2.1.7 Monitor Panel (See figure 1-12)

The monitor panel is used to facilitate monitoring salient signal points within the dual channel radiometer and is the primary means of establishing system parameters and checking operation prior to a shoot. It is cabled directly to the control chassis, and inspection points are selectable using the selector switches on the panel; thus oscilloscope leads need not be connected into the electronics console. Points which can be monitored are: AC signal (SIG) out. Rectified (RECT) and filtered signal out, 320 cps sync, calibration (CAL) state and ground (GND). The above test points are available from both channels and can be switched to the dual channel oscilloscope as desired. Two jacks for oscilloscope inputs are provided (CH-A, CH-B), allowing two signals from either channel or one signal from each channel to be monitored simultaneously.

1.2.1.8 Signals for Recording

The following signals are provided at the control electronics output connector for transmission to the digital tape recording subsystem:

1. A.C. Signal - Channels No. 1 and No. 2 -
   320 cps A.M. - 4.0 v rms max.

2. Synchronous reference (Channels No. 1 and No. 2)
   320 cps square wave, 20 v p.p. nom.

3. Null balance signal (Channels No. 1 and No. 2)
   320 cps square wave 0 to 10 v p.p. max.

4. Cal Gate and Level (Channels No. 1 and No. 2)
   50 millisecond pulse during automatic calibration.
   Four voltage steps +1, 2, 3, and 4 volts corresponding to 0, 20, 40, and 60 db injected calibrate.

5. Filter Position (Channels No. 1 and No. 2)
   four voltage levels +1, 2, 3, and 4 volts corresponding to filter position.

6. Internal reference cavity temperature - DC voltage
   related to temperature (0 - 10 volt max.).

Figure 1-12. Control and Monitor Panels

1.2.2 Vidicon TV System

The vidicon TV system is used to point the pedestal toward the target. Its output is displayed on a monitor on the operators' console in the instrumentation van. It permits the operator to see the events as they take place and to discriminate between the reentry vehicle and other parts of the missile reentering at the same time. Figure 1-13 shows the camera, lens, and mount. The camera also acts as the sensor in the servo loop consisting of the stiff-stick aided tracking system and the operator. The TV system used on GLOW was a high resolution vidicon Cohu Model 3000 camera with a 20-inch focal length optical system in front. The boresight of the vidicon camera is indicated by an adjustable reticle. It was realized at the time of the installation of this unit on White Sands Missile Range that the sensitivity of the vidicon was too low to properly observe a reentry vehicle but it had to be used until the Glint GE image orthicon system became available.

Figure 1-13. Vidicon TV Camera (Viewed from Bottom of Instrumentation Platform)

1.2.3 Boresight Camera

The boresight camera used on the GLOW system is a 35mm photo camera for the time-related recording of line-of-sight (boresight) tracking and instrument performance. Figure 1-14 shows the camera, lens, and mount.

The camera is a Model IV-CLF 35mm Multidata camera made by Flight Research Incorporated. Film format is single frame 35mm (0.720" x 0.960") and ASA Z22.34. The film magazine is externally mounted, dark room loaded, 400 foot capacity and contains a footage counter. Three illuminated fiducial markers are provided for night operation. The field-of-view is 1.0 x 1.3 degrees.

The camera is boresighted and focused by a 3X boresight microscope with cross hairs coincident with the camera fiducial markers. A separate camera mounting base containing micro-adjustments for the camera line-of-sight is used.

The camera lens is fabricated by Zoomar Incorporated, especially for the Flight Research camera. It is a 40 inch reflector lens, f/8, with an internal focusing device, from 600 feet to infinity.

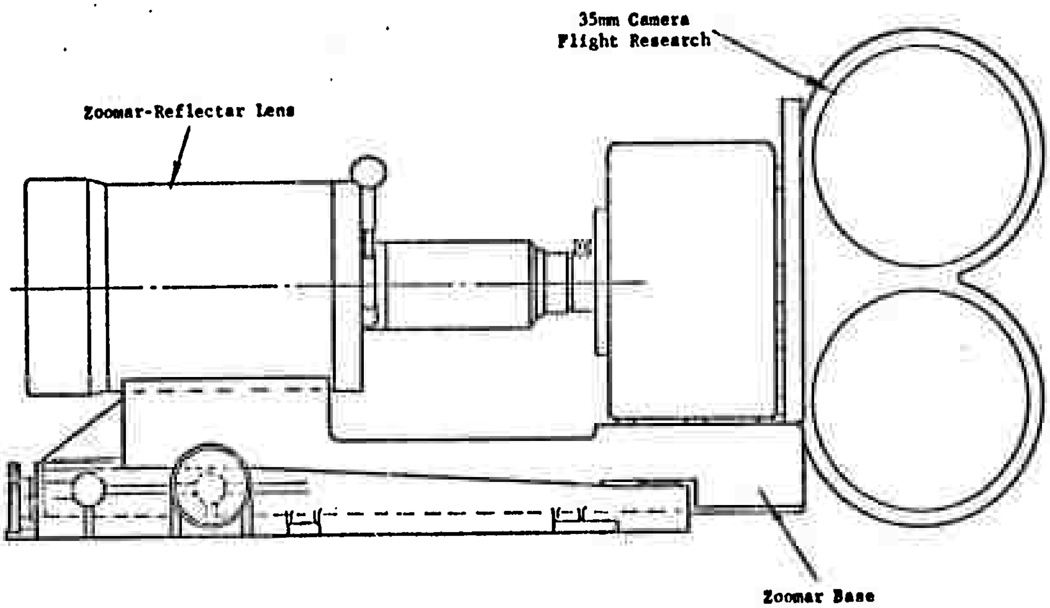


Figure 1-14. 35mm Boresight Camera

1.3 INSTRUMENTATION VAN

The instrumentation van is a 34-foot long semi-trailer van designed to house and transport electronic control and recording equipment for the GLOW program optical instrumentation system. Figure 1-15 shows the instrumentation van.

The instrumentation van is completely enclosed by an aluminum skin over a steel frame and chassis. The aluminum skin was selected for maximum resistance to erosion and oxidation and is insulated against galvanic corrosion.

The instrumentation van designed to meet all Interstate Commerce Commission (ICC) conditions and/or regulations, is permitted to be operated in all states of the Continental United States. The weight of the trailer unloaded is approximately 17,000 pounds. The trailer is designed to transport the mounted GLOW electronic equipment, weighing up to 12,000 pounds, including the air conditioning unit, over highways and unimproved roads.

Figure 1-15. Instrumentation Van

The suspension system is sufficiently self-leveling to accommodate moderate unequal distribution of load within the van and is capable of reducing maximum shocks to be expected under normal rough terrain conditions not exceeding 2.5 G's. A combination air ride and shock absorber suspension is used.

Trailer construction accommodates wiring through a connector panel located in the floor thence to distribution terminals, then to the appropriate equipment racks. Utility power, equipment power, and 400 cps servo power enters through connectors on the side of the van, then through circuit breakers, and remain as separate isolated circuits within the van. A double floor with three inch separation permits cabling distribution to any point in the van. Van construction allows electronic rack mounting through tap plates in the walls, ceiling, and floor of the van for adequate top and base rack fastening devices.

An air conditioning unit is mounted in a separate forward compartment. Figure 1-16 is a view of the forward compartment of the van. Conditioned and recovery air is ducted into and from the instrumentation area of the van.

Figure 1-16. Instrumentation Van Air Conditioning Compartment

Adequate filtering of fresh air inlets is provided for protection of equipment in a sand and salt air environment. The conditioned air is distributed through a duct system above the van ceiling, this duct work being equipped with adjustable dampers. The air conditioner consists of a single unit of 60,000 BTU's per hour cooling capacity and 12 KW of heating capability.

An air conditioner remote control panel is located inside the van equipment area. This panel includes the thermostat, humidistat, and selector switch controls.

All doors and access openings are provided with weatherproof gasketing to meet all climatic conditions. Flush type incandescent interior lighting is provided. Interior lighting within the forward control-display console area is separately controllable and includes wall-mounted, continuously-variable, brightness controls, conveniently located with reference to the entrance door. Brightness controls are provided for the instrumentation (rear) compartment interior lighting.

1.3.1 Operator's Console

The operator's console, shown in figure 1-17, is the nerve center for the tracking and pointing system. The tracking operator has visual presentations within his field-of-view for decision making purposes, and he has mode selection switches and a manual control stiff-stick at his fingertips. The console director (left side of console) monitors the autotracker functions, controls the data handling system, and starts and stops film recording instruments.

Visual null indicators, which were developed for this console, present error signals as a line presentation, clearly indicating both magnitude and direction of the error, or of the difference between actual pedestal angles and the pointing angles indicated by any of the other modes of operation.

The console is approximately 76 inches long, 24 inches wide, and 52 inches high with a 20 degree sloping front and a 14-inch wide table top. All panels and electronic chassis are of modular design and are slide mounted to facilitate servicing. The complete console weighs approximately 850 pounds. Appropriate functional displays such as a TV monitor, meters, switches, controls, and indicating lights allow the console director and console operator to monitor and control the instrument mounts and data recording devices. A digital clock on the console indicates time from lift-off. The desired tracking mode of operation is selected by the operator.

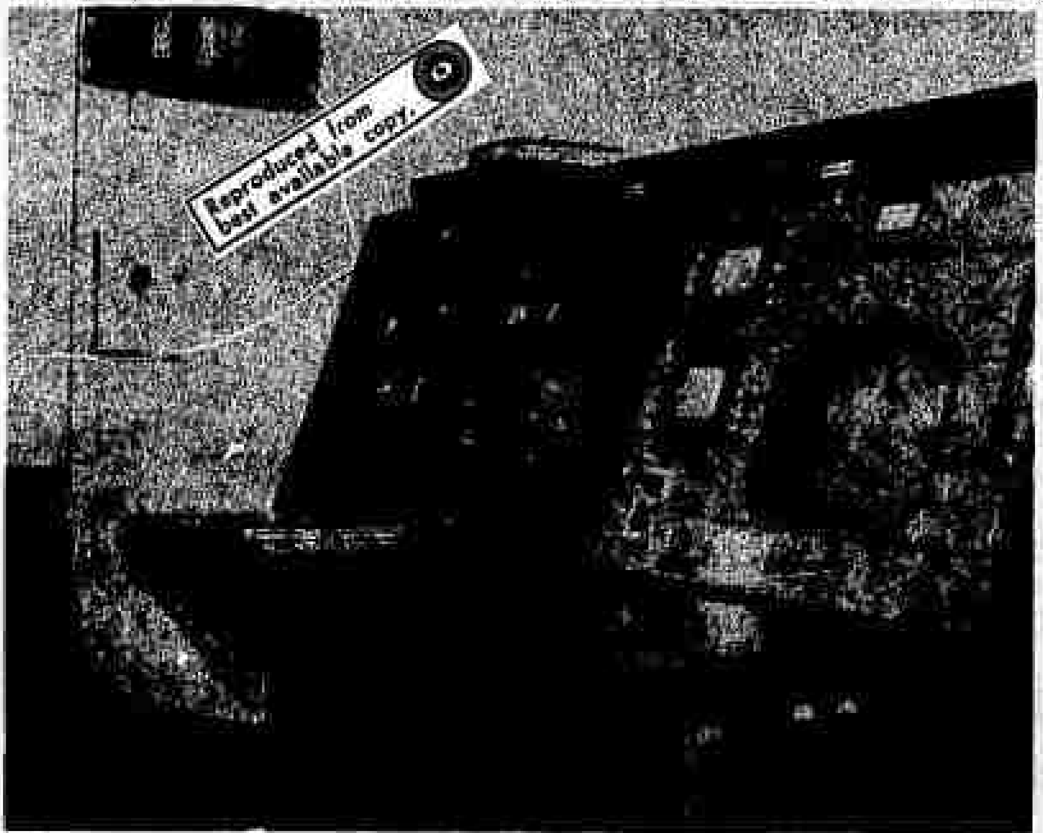


Figure 1-17. Operator's Console

1.3.2 Digital Data Handling System

The Digital Data Handling System consists of two digital magnetic tape units, control and hybrid digital/analog electronics, a Time Code Translator/Generator and a Kineplex data receiver. This equipment is packaged in four equipment racks and a consolette rack. The Digital Data Handling System controls the GLOW mount using command angle information provided by the IBM 7094 computer at WSMR or the GLOW SDS 930 computer at the Kwajalein installation. The system receives and digitizes analog instrumentation data, and records data and tracking information on magnetic tape in a format acceptable to an IBM computer. The system is logically divided into two subsystems as follows:

1. The Data Digitizing and Recording (DDR) Subsystem accepts as many as 64 analog inputs from radiometric and spectrometric instruments mounted on instrumentation platform. The subsystem digitizes and records the data, together with time and tracking data and other required information, on a continuous (gapless) tape. The

subsystem converts the gapless tape to gapped tape in an IBM format during a reformat process.

2. The Tracking Data (TD) Subsystem accepts command angle data from an IBM computer and actual GLOW mount position data from mount shaft angle encoders. The subsystem generates azimuth and elevation servo error signals to control the pedestal position and supplies tracking information to be recorded on magnetic tape.

Figure 1-18 depicts the data handling equipment. Figure 1-19 is a view of the equipment installed in the instrumentation van.

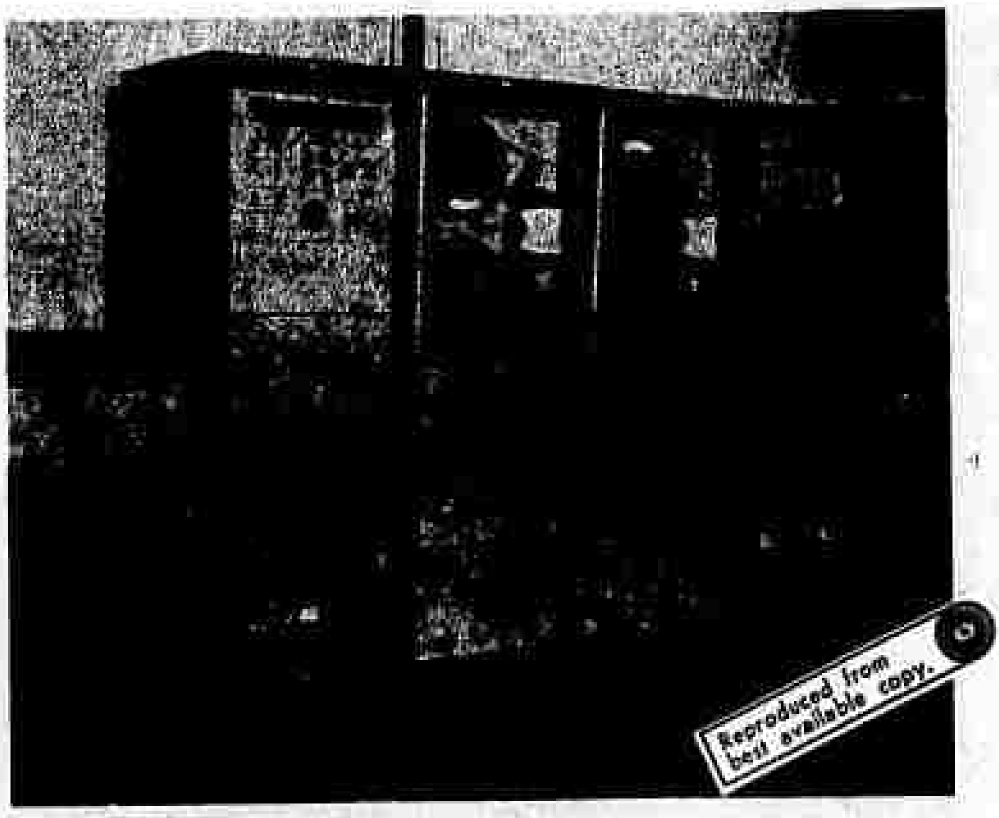


Figure 1-18. Data Handling Equipment

Figure 1-19. Data Handling Equipment Installed in the Instrumentation Van

Sixty-four channels of analog data are accepted as input to the DDR subsystem for multiplexing, digitizing, and recording on magnetic tape. Characteristics of the analog inputs are as follows:

Levels	-	±5 volts peak-to-peak
Loading	-	50 K ohm minimum
Sample Rate	-	200 samples per second

Time-of-day (17 bits) and millisecond time (10 bits) generated by an Astrodata Model 6420-806 Time Code Translator/Generator in IRIG B or C time code format are accepted and recorded by the DDR subsystem. Time code inputs are as follows:

Time of Day 17 lines	-	0 volts for binary one (1) -6 volts for binary zero (0)
Millisecond Code, 10 lines	-	Same as above
100 kc and 20 pps inputs	-	Same as above

A "jam" signal, provided by the DDR subsystem, causes the Time Code Translator/Generator to update the contents of the Time Code Translator/Generator output register just prior to recording time data. Eighteen lines representing discrete events or markers are accepted and recorded by the DDR subsystem. These inputs accept relay closures to ground for a binary zero and an open circuit for a binary one. Two magnetic tape formats are generated by the DDR subsystem. Prime, or gapless, tape is generated during the Operate modes, and secondary, or gapped, tape is generated from prime tape during the Reformat modes. The format of the prime tape is illustrated in figure 1-20. This format is written on both tapes simultaneously during operate modes. Each data block consists of one scan of the 64 digitized analog channels, events data, time data, and tracking data, recorded at a packing density of 556 bits per inch. Three additional tape character positions are reserved in each block for recording an inter-record configuration at appropriate intervals. The inter-record configuration is recorded between groups of 37 blocks. A blank code is recorded between all other blocks. Each group of 37 blocks is considered a record, and the inter-record configuration is detected on playback and used to generate a standard IBM inter-record gap in a tape-to-tape conversion operation. Records recorded on the prime tape terminate with two End-of-Record (EOR) characters, the second EOR character has even parity (a parity error) to uniquely identify the inter-record configuration. Any number of records may be written on the prime tape. When reformated, however, each record is followed by a standard IBM longitudinal parity character and an inter-record gap.

The secondary tape format is similar to the prime tape format, with the following exceptions:

a. An inter-record gap appears between the EOR and BOR characters. This includes the IBM longitudinal parity check character, and conforms to the IBM standard contained in IBM reference manual No. A22-6643 "IBM 729 II, IV, V, VI Magnetic Tape Units, Original Equipment Manufacturers' Information."

b. The second EOR character is recorded with correct (odd) parity.

c. EOF records are automatically recorded only as they occur on the prime tape.

Two types of tracking data are applied to the Tracking Data Subsystem: Command data (azimuth-elevation-range-identification) via the Kineplex receiver, and position data transmitted over cables from pedestal-mounted shift registers. Control and test signals are also transmitted and received from the pedestal equipment. (Command data, consisting of azimuth, elevation, range, and identification data, are received via a Model TE-210D-2 Kineplex receiver at a 20 message per second rate, in the format shown in figure 1-21.)* Position data consisting of 17 bits each of cyclic-binary (Gray) coded azimuth and elevation position angles are generated by Wayne-George Model No. RD-17 shaft angle encoders under tracking data subsystem control. On TD subsystem command the shaft angle encoders are strobed, and the resulting 34 bits of shaft angle data are transferred to pedestal-mounted shift registers. Shift pulses shift the data, most significant bit first, into similar shift registers in the Tracking Data Subsystem. Conversion from cyclibinary code to natural binary code is performed as part of this serial data transfer. Shaft angle encoder operations are checked with verification pulses generated and transmitted from the TD subsystem. Strobe monitor pulses from the shaft angle encoders are used for strobe echo error checks. TD subsystem interlocks assure stable pedstal operation. The interlocks are:

1. Kineplex Receive Level: This interlock signal indicates that the signal received at the Kineplex unit is too weak to assure receipt of error free data. This condition is indicated by the Kineplex Level indicator on the System Control Panel.

2. Kineplex Sync: This error indicates an out-of-sync condition with the Kineplex data, and a probability that improper data is being loaded into the TD subsystem registers.

3. Kineplex Test Alarm: This alarm indicates that the Kineplex receiver is in its self-test mode, and is not ready for operation.

---

*WSMR only

A

Condition II Channel Allocation	Allocation Nomenclature	1	2	4	8	A	B	C	Tape Character	Condition I Data
	BOB 1 (1)	0	0	0	0	0	0	1	1	
	Time of Day	T	T	T	T	T_{msb}	0	P	2	
		T	T	T	T	T	T	P	3	
		T_{Lsb}	T	T	T	T	T	P	4	
	Time M. Sec.	T	T	T	T	T	T_{msb}	P	5	
		0	0	T_{Lsb}	T	T	T	P	6	**Condition I Data**
	Events	Eb	Eb	Eb	Eb	Ea	Ea	P	7	Ea MSB Day of Year (3)
		Ed	Ed	Ec	Ec	Ec	Ec	P	8	Eb Day of Year (6)
		Ee	Ee	Ee	Ee	Ed	Ed	P	9	Ec LSB Day of Year (5)
Spec /0°	CH 1	As	As	As	As_{msb}	As_{sign}	0	P	10	Ed Year
		As_{Lsb}	As	As	As	As	As	P	11	Ee System & Site Location
Spec /90°	CH 2	As	As	As	As_{msb}	As_{sign}	0	P	12	
		As_{Lsb}	As	As	As	As	As	P	13	
Spec Wave length	CH 3								14	Ch 3 Spec Operating Mode
(s)									15	
Rad Ch A1/0°	CH 4								16	
									17	
Rad Ch A1/90°	CH 5								18	
									19	
Rad Cal Gate 1A	CH 6		Analog Data						20	Ch 6 RAD A1 Filter Pos.
									21	
Rad Ch A2/0°	CH 7								22	
									23	
Rad Ch A2/90°	CH 8								24	
									25	
Rad Cal Gate 1B	CH 9								26	Ch 9 RAD A2 Filter Pos.
									27	
Spec /0°	CH 10	As	As	As	As_{msb}	As_{sign}	0	P	28	
		As_{Lsb}	As	As	As	As	As	P	29	
Spec /90°	CH 11	As	As	As	As_{msb}	As_{sign}	0	P	30	
		As_{Lsb}	As	As	As	As	As	P	31	
[illegible] Spec Gate	CH 12								32	Ch 12 Spec Cavity Temp.
									33	
Rad Ch B1/0°	CH 13								34	
									35	
Rad Ch B1/90°	CH 14								36	
									37	
Rad Cal Gate 2A	CH 15								38	Ch 15 RAD B1 Filter Pos.
									39	
Rad Ch B2/0°	CH 16		Analog Data						40	
									41	
Rad Ch B2/90°	CH 17								42	
									43	
Rad Cal Gate 2B	CH 18								44	Ch 18 RAD B2 Filter Pos.
									45	
Spec /0°	CH 19	As	As	As	As_{msb}	As_{sign}	0	P	46	
		As_{Lsb}	As	As	As	As	As	P	47	
Spec /90°	CH 20	As	As	As	As_{msb}	As_{sign}	0	P	48	
		As_{Lsb}	As	As	As	As	As	P	49	
IR Tracker Δx	CH 21								50	Ch 21 Cine Frame Rate
									51	
IR Tracker Δy	CH 22								52	Ch 22 Cine Grating Pos.
									53	
IR Radiation Sig	CH 23								54	
									55	
Vis Tracker Δx	CH 24								56	Ch 24 RAD A Cavity Temp.
									57	
Vis Tracker Δy	CH 25		Analog Data						58	Ch 25 RAD B Cavity Temp
									59	
Vis Rad Sig	CH 26								60	Ch 26 Spec Shutter Pos.
									61	
Spare	CH 27								62	
									63	
Spec /0°	CH 28	As	As	As	As_{msb}	As_{sign}	0	P	64	
		As_{Lsb}	As	As	As	As	As	P	65	
Spec /90°	CH 29	As	As	As	As_{msb}	As_{sign}	0	P	66	
		As_{Lsb}	As	As	As	As	As	P	67	
Spare	CH 30								68	
									69	
Spare	CH 31								70	
									71	
Spare	CH 32								72	
									73	Typical of all analog channels -
Spare	CH 33								74	A bit in the sign position
									75	indicates a negative number
Spare	CH 34		Analog Data						76	
									77	
Spare	CH 35								78	
									79	
Spare	CH 36								80	
									81	
Spec /0°	CH 37	As	As	As	As_{msb}	As_{sign}	0	P	82	

Spare	CH 33								73
									74
Spare	CH 34			Analog Data					75
									76
Spare	CH 35								77
									78
Spare	CH 36								79
									80
Spec /0°	CH 37								81
		As	As	As	As_{msb}	As_{sign}	0	P	82
Spec /90°	CH 38	As_{Lsb}	As	As	As	As	As	P	83
		As	As	As	As_{msb}	As_{sign}	0	P	84
		As_{Lsb}	As	As	As	As	As	P	85
Spare	CH 39								86
									87
Spare	CH 40								88
									89
Spare	CH 41								90
Spare	CH 42			Analog Data					91
									92
Spare	CH 43								93
									94
Spare	CH 44								95
									96
Spare	CH 45								97
									98
Spec /0°	CH 46								99
		As	As	As	As_{msb}	As_{sign}	0	P	100
Spec /90°	CH 47	As_{Lsb}	As	As	As	As	As	P	101
		As	As	As	As_{msb}	As_{sign}	0	P	102
		As_{Lsb}	As	As	As	As	As	P	103
Spare	CH 48								104
									105
Spare	CH 49								106
									107
Spare	CH 50								108
									109
Spare	CH 51								110
									111
Spare	CH 52			Analog Data					112
									113
Spare	CH 53								114
									115
Spare	CH 54								116
									117
Spec /0°	CH 55	As	As	As	As_{msb}	As sign	0	P	118
		As_{Lsb}	As	As	As	As	As	P	119
Spec / 90°	CH 56	As	As	As	As_{msb}	As sign	0	P	120
		As_{Lsb}	As	As	As	As	As	P	121
	Range Data	R	R	R	R	R	R_{msb}	P	122
		R^{12th}_{Lsb}	R	R	R	R	R	P	123
	Command Azimuth Angle Data (via Kineplex)	C'	C	C'	C'	C'_{msb}	O'	P	124
		C'	C'	C'	C'	C'	C'	P	125
		C'_{Lsb}	C'	C'	C'	C'	C	P	126
	Command Elevation Angle Data (via Kineplex)	Y	Y	Y	Y	Y_{msb}	O	P	127
		Y	Y	Y	Y	Y	Y	P	128
		Y_{Lsb}	Y	Y	Y	Y	Y	P	129
	Position Azimuth Angle Data (via Shaftencoder)	As	As	As	As	As_{msb}	O	P	130
		As	As	As	As	As	As	P	131
		As_{Lsb}	As	As	As	As	As	P	132
	Position Elevation Angle Data (via Shaftencoder)	EL	EL	EL	EL	EL_{msb}	O	P	133
		EL	EL	EL	EL	EL	EL	P	134
		EL_{Lsb}	EL	EL	EL	EL	EL	P	135
Spec /0°	CH 57	As	As	As	As_{msb}	As_{sign}	0	P	136
		As_{Lsb}	As	As	As	As	As	P	137
Spec /90°	CH 58	As	As	As	As_{msb}	As_{sign}	0	P	138
		As_{Lsb}	As	As	As	As	As	P	139
	Azimuth Error Angle Data 1st Difference (6) Condition State Elevation Error Angle Data	0	0	θ_{msb}	θsign	0	0	P	140
		θ_{Lsb}	θ	θ	θ	θ	θ	P	141
		0	0	0	0	0	0	P	142
		0_I	0_{II}	0	0	0	0	P	143
		ϕ	ϕ	ϕ_{msb}	ϕsign	0	0	P	144
	1st Difference (6)	ϕ_{Lsb}	ϕ	ϕ	ϕ	ϕ	ϕ	P	145
	File Counter	0	0	0	0	0	0	P	146
	CH 59	0_{Lsb}	0	0	0	0 Msb	0	P	147
								P	148
	CH 60			Analog Data				P	149
								P	150
	CH 61							P	151
								P	152

Typical of all analog channels - A bit in the sign position indicates a negative number

Tape Motion ⟵

Tape is shown with oxide side up, Read/write head on same side as oxide

Condition II Data

Character 7

B	Bore-site Camera
A	OSC Rec-Run
8	Spare
4	Spare
2	Spare
1	Impact (stop)

Character 8

B	Manual Mode
A	Sighting Station Mode
8	Spare
4	Narrow Field (Autotracker)
2	Cine Spec Camera (Run)
1	Rinescope Camera (Run)

Character 9

B	Spare
A	Radar Slave Mode
8	Wide field (Autotracker)
4	Autotracker Ind Signals
2	Autotracker Ind Signals
1	Autotracker Ind Signals

Abbreviations

1 - Rad = Radiometer
2 - Spec = Spectrophotometer
3 - Cal Gate = Calibration Gate
4 - Vis = Visible
5 - IR = Infra Red
6 - Ch = Channel

									109
Spare	CH 51								110
									111
Spare	CH 52		Analog Data						112
									113
Spare	CH 53								114
									115
Spare	CH 54								116
									117
Spec /0°	CH 55	As	As	As	As_{msb}	As_{sign}	0	P	118
		As_{Lsb}	As	As	As	As	As	P	119
Spec /90°	CH 56	As	As	As	As_{msb}	As_{sign}	0	P	120
		As_{Lsb}	As	As	As	As	As	P	121
	Range Data	R	R	R	R	R	R_{msb}	P	122
		R^{12th}_{Lsb}	R	R	R	R	R	P	123
	Command Azimuth Angle Data	C'	C	C'	C'	C'_{msb}	0'	P	124
	(via Kinaplex)	C'	C'	C'	C'	C'	C'	P	125
		C'_{Lsb}	C'	C'	C'	C'	C	P	126
	Command Elevation Angle Data	Y	Y	Y	Y	Y_{msb}	0	P	127
	(via Kineplex)	Y	Y	Y	Y	Y	Y	P	128
		Y_{Lsb}	Y	Y	Y	Y	Y	P	129
	Position Azimuth Angle Data	As	As	As	As	As_{msb}	0	P	130
	(via Shaftencoder)	As	As	As	As	As	As	P	131
		As_{Lsb}	As	As	As	As	As	P	132
	Position Elevation Angle Data	EL	EL	EL	EL	EL_{msb}	0	P	133
	(via Shaftencoder)	EL	EL	EL	EL	EL	EL	P	134
		EL_{Lsb}	EL	EL	EL	EL	EL	P	135
Spec /0°	CH 57	As	As	As	As_{msb}	As_{sign}	0	P	136
		As_{Lsb}	As	As	As	As	As	P	137
Spec /90°	CH 58	As	As	As	As_{msb}	As_{sign}	0	P	138
		As_{Lsb}	As	As	As	As	As	P	139
	Azimuth Error	θ	θ	$θ_{msb}$	$θ_{sign}$	0	0	P	140
	Angle Data	$θ_{Lsb}$	θ	θ	θ	θ	θ	P	141
	1st Difference (6)	0	0	0	0	0	0	P	142
	Condition State	0_{I}	0_{II}	0	0	0	0	P	143
	Elevation Error Angle Data	ϕ	ϕ	$ϕ_{msb}$	$ϕ_{sign}$	0	0	P	144
		$ϕ_{Lsb}$	ϕ	ϕ	ϕ	ϕ	ϕ	P	145
	1st Difference (4)	δ	0	0	0	0	0	P	146
	File Counter	C_{Lsb}	0	0	0	0_{Msb}	0	P	147
	CH 59							P	148
								P	149
	CH 60		Analog Data					P	150
								P	151
	CH 61							P	152
								P	153
Spec /0°	CH 62	As	As	As	As_{msb}	As_{sign}	0	P	154
		As	As_{Lsb}	As	As	As	As	P	155
Spec /90°	CH 63	As	As	As	As_{msb}	As_{sign}	0	P	156
		As	As_{Lsb}	As	As	As	As	P	157
Error Ref Unit-age	CH 64							P	158
			Analog Data					P	159
	ID	I	I	I	I	I	I	P	160
	EOB 1 (1)	0	0	0	0	0	0	I	161
	EOB 2 (1)	0	0	0	0	0	0	I	162

As	Analogue Channel Super Commutating
As	Position Azimuth Angle Data
EL	Position Elevation Angle Data
R	Range
C	Command Azimuth Angle Data
Y	Command Elevation Angle Data
θ	Azimuth Error Angle Data
ϕ	Elevation Error Angle Data
R	Events Data
I	I.D. Data
T	Time Code Data
δ	Two Characters Reserved for 1st and 2nd Differences
C	Parity Track
BOB	Beginning of Block
BOR	Beginning of Record
EOR	End of Record
Lsb	Least Significant Bit
msb	Most Significant Bit

Super Commutating Channels - CH [illegible],47,55,56, [illegible]

PERKIN-ELMER — ELECTRO-OPTICAL DIVISION, NORWALK CONNECTICUT — "GLOW" FINAL BLOCK FORMAT

Condition II Data

Character 7

8	Bore-site Camera
A	OSC Rec-Run
B	Spare
4	Spare
2	Spare
1	Impact (stop)

Character 8

B	Manual Mode
A	Sighting Station Mode
8	Spare
4	Narrow Field (Autotracker)
2	Cine Spec Camera (Run)
1	Kinescope Camera (Run)

Character 9

B	Spare
A	Radar Slave Mode
8	Wide field (Autotracker)
4	Autotracker Ind Signals
2	Autotracker Ind Signals
1	Autotracker Ind Signals

Abbreviations

1 - Rad = Radiometer
2 - Spec = Spectrophotometer
3 - Cal Gate = Calibration Gate
4 - Vis = Visible
5 - IR = Infra Red
6 - Ch = Channel
7 - /0° = Inphase signal
8 - /90° = Quadrature signal

Notes:

(1) Beginning and end of Block Characters (BOB, EOB 1,2) are blank or all zeros. Beginning and end of Record Characters (BOR, EOR 1,2) are all ones.

(2) One record consists of n blocks with the first block containing a BOR character and the n[th] block containing EOR1 and EOR2 characters. All other blocks within the record have BOB and EOB1 and EOB 2 characters.

(3) In Azimuth & Elevation error data a bit in the sign position indicates a positive value.

In all Analog Channels a bit in the sign position indicates a negative value.

(4) [illegible] Characters = 1 block
[illegible] blocks = 1 record
[illegible] records = 1 file

Figure 1-20. GLOW Block Format

4. Strobe Echo: Occurrence of a strobe echo, indicated separately as Azimuth Echo and Elevation Echo, warns of improper operation of a shaft angle encoder.

When any of the above interlock signals occur, the TD subsystem will automatically zero the azimuth and elevation difference outputs to prevent random operation of the tracking pedestal.

The tracking data outputs consist of three analog signals and one digital control line.

1. Range: Range output is an analog signal derived from the 12 bits of digital range received via Kineplex, and has a full-scale output of zero to -20 volts, with a constant output impedance of 10 K ohms.

2. Azimuth and Elevation Errors: Azimuth and elevation error signals are generated by digitally subtracting the position angle derived from the pedestal mounted shaft angle encoders from the command angle received via Kineplex. Only the 8th through the 16th bits and a sign bit of the resulting differences are stored and converted to analog output form. If the subtraction process results in a difference exceeding the 8th bit, the difference register is set to all ones or all zeros (± full scale), depending on the sign of the difference.

   The analog output signals are bi-polar, zero to ±6.67 volts (no load), with an output impedance of 6,667 ohms. With 10 K ohm load, the output levels drop to about ±4 volts full scale.

3. Strobe Mode: The strobe mode signal is on (-10 volts) during the time the TD subsystem is operating and strobing the shaft angle encoders. The signal is off (0 volts) at all other times.

The system consists of two digital magnetic tape units, control and hybrid digital electronics, an Astrodata Time Code Translator/Generator, and a Kineplex data receiver. This equipment is packaged in four equipment racks and a consolette rack. Refer to figure 1-18.

Channels	15	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1
#1	R_2	0	A_1	A_2	0	E_1	E_1	MR_2	0	A_2	A_2	0	E_2	I	E_2	R_2	0
#2	R_2	MA_1	A_1	A_1	ME_1	E_1	E_1	R_2	MA_2	A_2	A_2	ME_2	E_2	I	E_2	R_2	MA_1
#3	R_2	A_1	A_1	A_1	E_1	E_1	E_1	R_2	A_2	A_2	A_2	E_2	E_2	I	E_2	R_2	A_1
#4	R_2	A_1	A_1	A_1	E_1	E_1	E_1	R_2	A_2	A_2	A_2	E_2	E_2	I	E_2	R_2	A_1
#5	R_2	A_1	A_1	A_1	E_1	E_1	E_1	R_2	A_2	A_2	A_2	E_2	E_2	I	E_2	R_2	A_1
#6	LR_2	A_1	A_1	LA_1	E_1	E_1	LE_1	R_2	A_2	A_2	LA_2	E_2	E_2	I	LE_2	LR_2	A_1
#7	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
#8																	

50 Milliseconds

1 Message — 15 Frames

Modified "40" Message Per Second Format

R = Range
A = Azimuth
E = Elevation
I = Identification

MA, ME, MR = Most Significant Bit Azimuth, and Elevation Range

LA, LE, LR = Lease Significant Bit Azimuth, Elevation and Range

Figure 1-21. Typical Kineplex Message Format

Rack 1 contains logic cases 1, 2, 3, and 4, the System Control Unit, a PBC Model M2 Multiverter, a PBC Model EM-3 Multiplexer, and a Model MCD2-DA5 Digital-to-Analog converter. The System Control Panel, which provides switches and indicators for local and manual operation of the system, is mounted on the system control unit. Additional system status displays are mounted on the panels of the other units.

Logic case 1 contains the tracking-error-generator portions of the tracking data subsystem, and part of the tracking data buffer. The front panel has 34 indicator lamps, 17 each for command and position angles. A rotary switch on the panel permits selection of either azimuth or elevation data for display.

Logic case 2 contains the Kineplex and pedestal interface logic and the tracking data subsystem control logic. Two sets of 17 switches are mounted on the front panel for selection of fixed azimuth and elevation command angles during Condition 1 operations.

Logic case 3 contains the digital multiplexer logic and part of the tracking data buffer. The front panel indicators display the state of the digital multiplexer counters.

Logic case 4 contains magnetic tape unit interface logic, tape movement and tape read/write control logic, and an 11-bit analog data buffer register. Front panel indicators display the status of key elements of the tape control logic.

Rack 2 contains a Potter Model 906-II-2 transistorized digital magnetic tape handler capable of reading or writing tapes in IBM compatible format. A power control panel, blower, and isolation transformer are also mounted in the rack. Rack 3 is similar to Rack 2 except the digital magnetic tape unit contains no read electronics. The Astrodata Time Code Translator/Generator is housed in Rack 4.

Two IBM compatible digital magnetic tape transport units are provided with the Digital Data Handling System. Manufactured by the Potter Instrument Company, the tape units are identical except that one contains both read and write amplifier circuits and one contains write amplifier circuits only. Both units contain:

1. One Model 906-II-2 Transistorized Digital Magnetic Tape Handler with the following specifications:

a. Tape speed 60 ips, rewind speed 240 ips
b. Tape width 1/2"
c. IBM type hubs
d. Isolation transformer (mounted separately at bottom of rack).

2. IBM type End-of-Tape and Beginning-of Tape sensors including dual channel amplifiers.

3. Model 6400 series IBM compatible single gap magnetic read/write head for operation at 556/200 bits per inch packing density.

4. Model 3321-01R Manual Pushbutton Control Station.

The tape transport in rack 2 has a Model MA315-2 Transistorized Amplifier System for reading and writing IBM compatible 556/200 bpi tapes. The amplifier system consists of the following components:

1. Seven channels of write amplifiers with head compensation.

2. Seven channels of peak detection playback amplifiers with head compensation.

3. IBM compatible clock generator module giving 7 channels of strobed output.

4. All required power supplies, interconnecting cables, and extension frames.

The tape transport in rack 3 is identical to that in rack 2 except the read amplifier circuit cards and the read head cable are not supplied.

The Government furnished equipment items described in the following paragraphs are part of the Digital Data Handling System.

A Kineplex serial/parallel 2400 BPS Digital Data Modem, Model TE-210D-2, manufactured by the Collins Radio Company is provided for the system. The Kineplex unit supplies binary tracking data and control signals to the Tracking Data subsystem:

1. Data Output:

   Eight parallel 300-bits-per-second, synchronous, binary channels, -5.5 to -6.5 volts for binary zero (0) and +0.2 to -0.2 volts for binary one (1), 600 ohms maximum output impedance.

2. Data Rate Timing Output:

   Bipolar square waves 3.6 to 6.0 volts peak-to-peak at 600, 1200, or 2400 pps, 600 ohms maximum output impedance.

3. 300 cps and 600 cps Output:

   Zero to -6 volts, 600 ohms output impedance.

4. Receive Level Alarm:

   A relay closure upon loss of input signal to the Kineplex.

5. Test Alarm:

   A switch closure when the Kineplex is in the self-test mode.

An Astrodata Model 6420-806 Time Code Translator/Generator in its own equipment rack (rack 4) is provided with each Digital Data Handling System. The unit provides the following outputs to the Digital Data Handling System:

1. Time-of-Day, 17 lines: 0 volts for binary one (1) -6 volts for binary zero (0).

2. Millisecond Code, 10 lines: same as above.

A "jam" signal input to the Time Code Translator/Generator is supplied by the Digital Data Handling System at least 200 μ sec. before data from the Time Code Translator/Generator is to be used, to allow the Time Code Translator/Generator to update data in the output register.

Primary power is supplied separately to each of the equipment racks. Primary power for the Digital Data Handling System is 115 volts, 60 cycle, single phase, three-wire. A service outlet is provided in each rack. The power requirements for each rack, exclusive of service power, are tabulated below:

Rack 1	-	5 amps
Rack 2	-	8 amps
Rack 3	-	8 amps

Power in each rack is controlled by dual Heinemann circuit breakers located on the Power Control Panels.

The Digital Data Handling System operates in the instrumentation van shielded against interference from electrostatic and electromagnetic fields. The system operates in the following environmental conditions:

1. Temperature - +10° to +45°C
2. Humidity - 10% to 90% relative
3. Altitude - Up to 10,000 feet

1.4 TARGET BOARD

The system instruments may be boresighted prior to a mission by use of a target board located approximately 1000 feet from the GLOW mount. Each instrument has its own boresight scope either permanently affixed to it or an access port is provided on the instrument for insertion of a boresighting tool.

The GLOW mount is provided with a boresighting telescope and bracket mounted on the elevation axis. The target board is shown in figure 1-22. It is an extremely rigid frame made up of "Unistrut" channel material, suitably braced, bolted and secured in concrete piers. Targets and light sources, as required for each individual instrument, are made up in "Universal" type mounting fixtures, affixed to the target board frame, and positioned on the board so as to eliminate parallax errors when boresighted. The target board allows maximum flexibility for interchanging targets or relocating them as new instruments are added to the system. It also makes boresight check possible without regard to cloud cover.

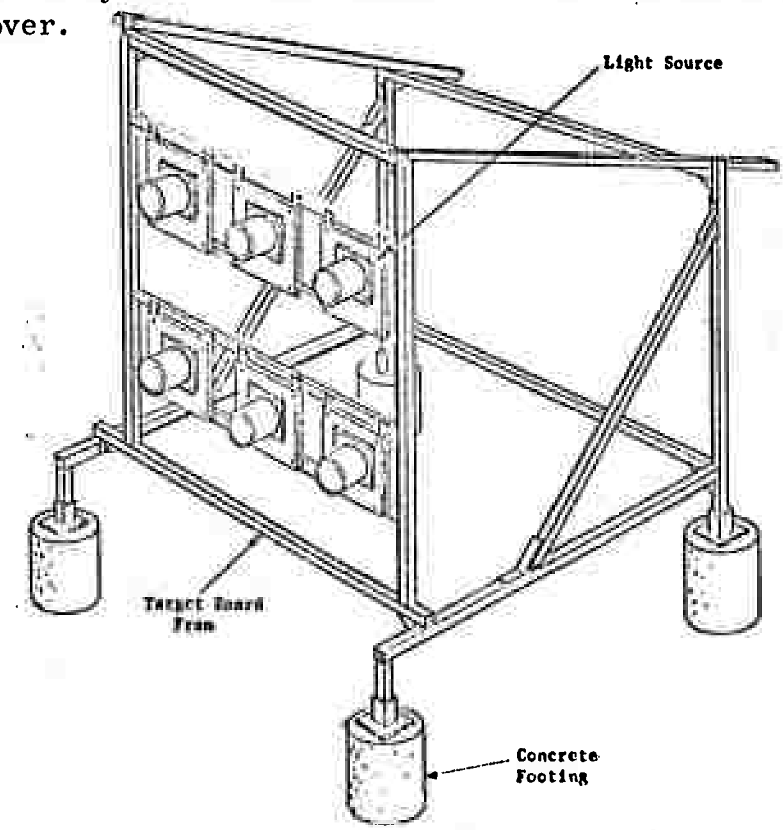


Figure 1-22. Target Board

1.5 CALIBRATION COLLIMATOR

A precision reference collimator system is provided in order to facilitate field calibration of the GLOW instruments (see figure 1-23). The calibration system consists of a large aperture, all-reflective, collimator with a precise, controlled energy source. Appropriate alignment sights and position controls are provided to enable the operator to set up quickly on the various instruments.

The calibration collimator (with source) is mounted on a concrete pier, located within 50 feet of the GLOW mount, with the railbed positioned tangent to a circle concentric to the azimuth axis of the GLOW mount (see figure 1-24). Horizontal translation of the collimator on the railways and vertical angular position about the collimator's horizontal mounting axis provide for alignment of the collimator axis to any one of the instruments on the GLOW mount. The combined use of a direct viewing telescope mounted on top of the collimator, and a reflex viewing system through the collimator optics, enables the operator to guide the positioning of the collimator optic axis to coincide with the axis of a particular instrument on the GLOW mount.

A choice of aperture sizes for the blackbody source field stop, along with a variable temperature control for the blackbody, provides a wide range of energy levels from the collimator. There is a secondary source available, in that the illuminating Osram lamp with mercury spectral bands or peaks can be used as a source. Optical filters are available for insertion into the energy beam, providing spectral region control. A mechanical chopper provides square wave modulation of the source energy, as desired, for instrument dynamic performance evaluation. Provision is made for making precise field-of-view tests on the instruments.

The collector system of the 12-inch calibration collimator utilizes a parabolic primary mirror and a hyperbolic secondary mirror in the standard Cassegrain configuration. The effective focal length (EFL) of the collector system is 15.14 inches, which results in an overall collector speed of f/4.35. Nominal on-axis imagery is 20 microns.

The collector system is housed in an aluminum alloy casting. The primary mirror is supported on 3/8-inch diameter, 50 durometer silicon rubber that extends around the complete periphery of the mirror. This ring allows for differential expansion between the mirror and the housing throughout the expected temperature range and also provides a shock resistant mounting for the mirror. The secondary mirror is also mounted with a rubber, shock-absorbing member.

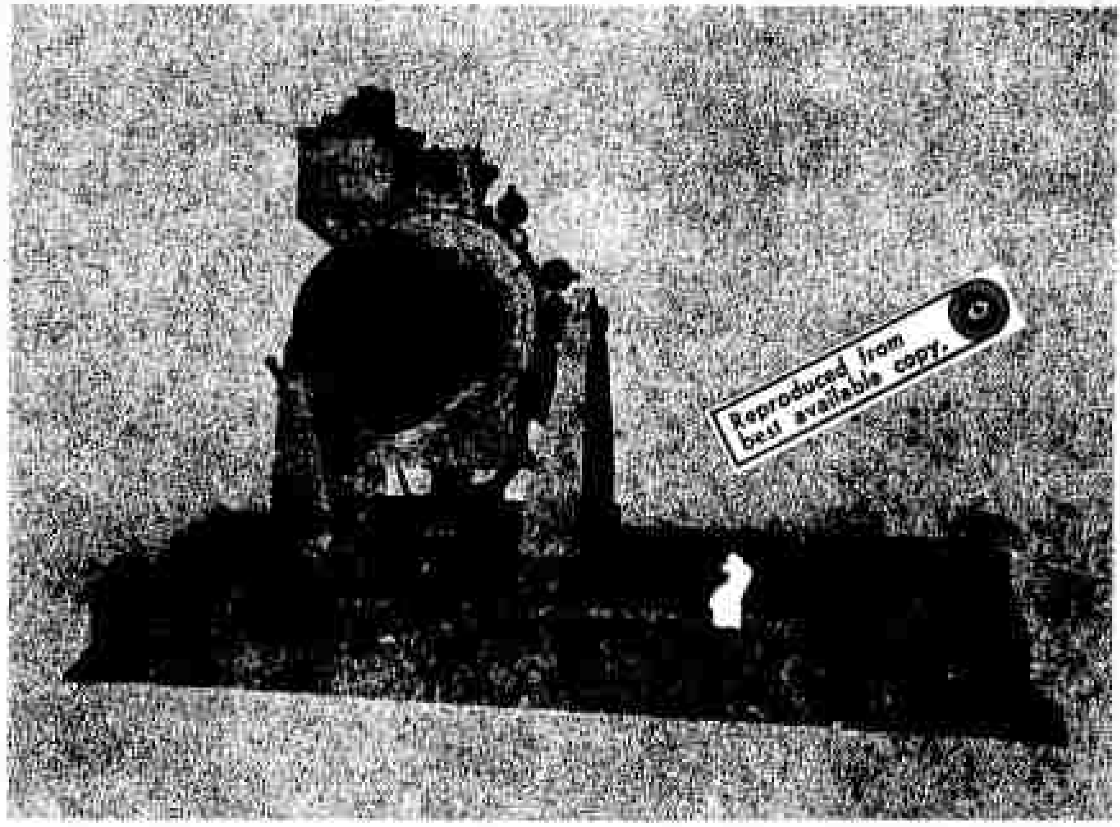


Figure 1-23. Calibration Collimator

The Cassegrain optics perform the dual system functions of collector and projector. Energy at the focal point of the optical axis is collected and then projected to the instrument to be calibrated. As a projection system the unit projects energy from a blackbody source through a selection of various diameter pin holes and filters. Two index wheels are used to allow combinations of different pinhole apertures and filters. Each wheel contains six index positions; one wheel has six filter holders, the other has six pinholes (field stops) of varying aperture size. Both pinhole and filter selections are made manually by knobs located on the light modulator assembly at the rear of the collimator.

Three possible focal point positions within the calibrator are provided for the collector system. The focal planes that are utilized are determined by the position of the flip mirror.

When the flip mirror is in the down position, the blackbody field stop is at the focal plane No. 1 of the collector system and a 5X boresight scope is in position for x and y alignment of the collimator with respect to the instrument under test.

When the flip mirror is in up position the calibrator:

1. projects visible collimated light from the Osram source to illuminate the focal plane of the instrument under test.

2. provides a 50X telescope through which the illuminated focal plane of the instrument under test may be viewed.

The dual capability which is realized when the mirror is in the down position is accomplished optically by a beamsplitter in the optical path. By centering the field stop at the focal plane of the test instrument on the crosshair reticle of the calibrator telescope system, the optical axis of the calibrator is rendered parallel to the optical axis of the instrument under test. Thus by using both positions of the flip mirror, it is possible to assure that the optical axis of the collimator and the instrument under test are parallel and coincident with one another.

The light source that is used for the projection system is an Osram type HBO 100 W/2 high pressure mercury lamp. Light from the lamp is transferred to the rear projection screen, located at focal plane No. 3, by a Schneider Zenon lens system. Cooling for both the lamp and the lens is provided by a vane-axial fan and an adjustable baffle to regulate the air flow. The ignition system for the Osram lamp is mounted in the same aluminum casting and both units are accessible through a cover plate.

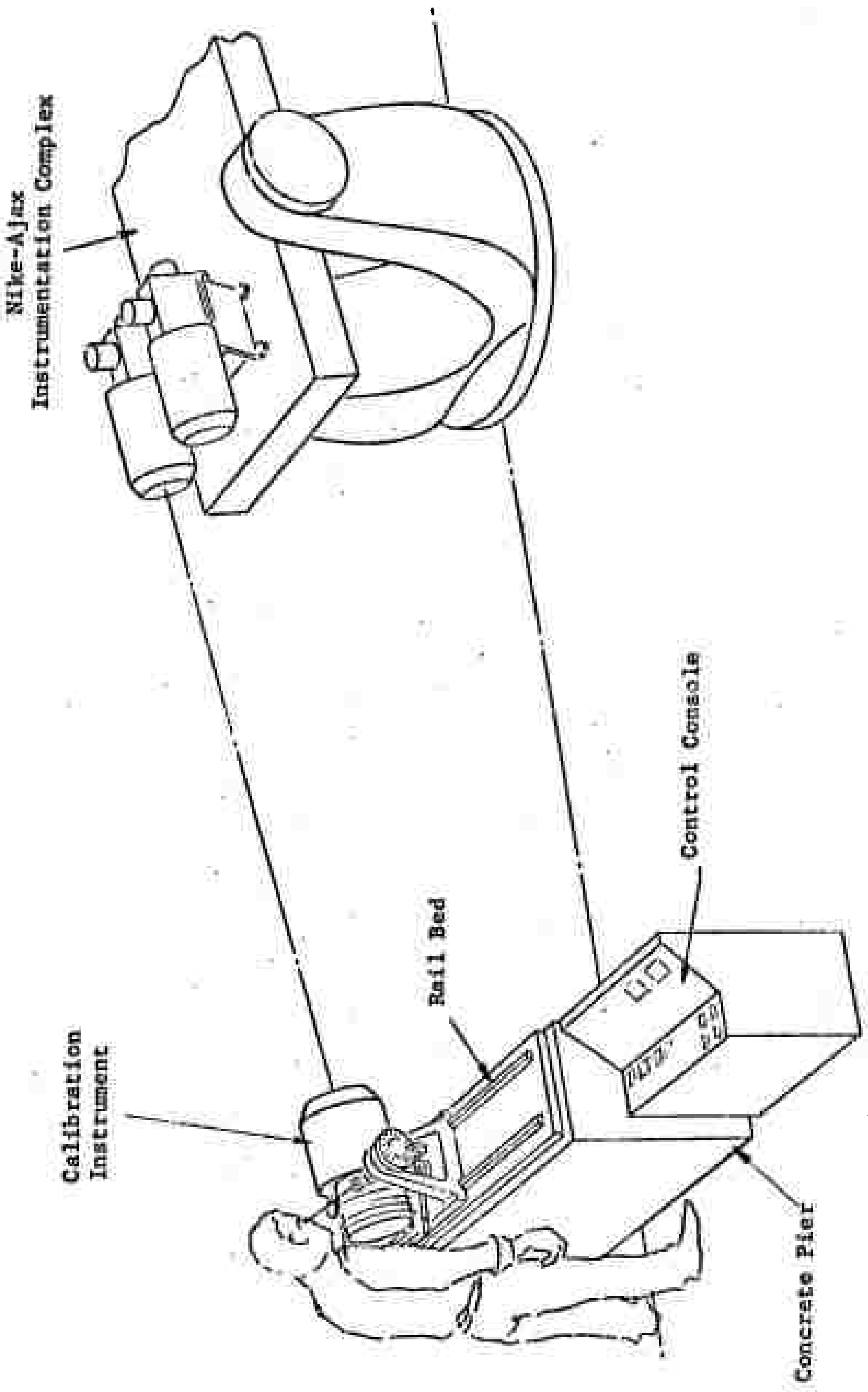


Figure 1-24. Calibration Instrument at GLOW

To provide for alignment of the calibrator with respect to the x and y axes of the instrument under test, the entire unit is mounted upon a trunnion and slide axis to allow positioning of the carriage to within ±1/32 inch. A rack and pinion drive that is manually operated through a hand wheel is provided to move the trunnion along the railbed. Precision ground and polished ways allow the trunnion to slide over a distance of 40 inches while retaining angular position to within 10 arc-seconds. An elevation drive and lock system allows elevation adjustments with a precision of ±15 arc-seconds.

1.5.1 Control Console

The control console shown in figure 1-24 and 1-25 is a sealed electronic cabinet which is a functional part of the calibration collimator system. The control console contains a control panel with on-off switches for main power, the Osram lamp, and the blackbody modulator. It also contains the power supply for the Osram lamp and a radiation source temperature controller.

Packaging and electronic wiring within the control console provides a flexible arrangement for system growth. For this purpose the following has been provided: a radio frequency interference filter at the AC input termination to limit conducted interference, space within console cabinet for future subassemblies, and terminal strips to provide power and control functions for the future subassemblies.

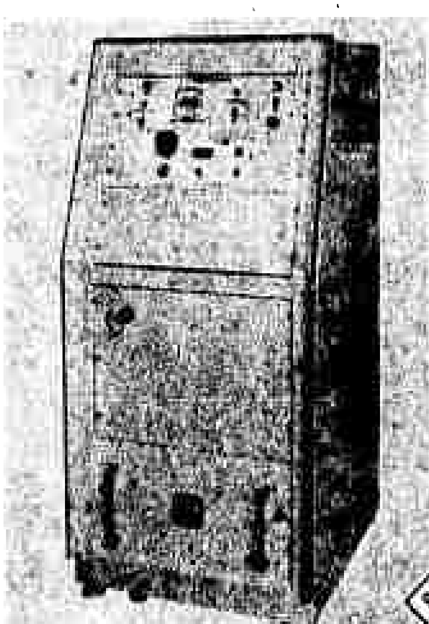


Figure 1-25. Control Console

1.6 UTILITY VAN

The utility van (see figure 1-26) is a 28-foot long semi-trailer van (GFE) which provides storage and maintenance facilities for the GLOW site. The van also contains a darkroom. A view of the van interior is shown in figure 1-27. Storage cabinetry, heater-air conditioner and B-50 manual sighting station support are also shown.*

1.6.1 B-50 Manual Sighting Station

A B-50 manual sighting station (see figure 1-27) was chosen for a visual means of target acquisition, i.e., a manual sighting station for the GLOW system. The GLOW mount is synchro-slaved to the sighting station during periods of time when the sighting station is the mode of acquisition. In order to make the B-50 station compatible with the GLOW system it was modernized and refurbished.

Figure 1-26. Utility Van

*At the Kwajalein installation, the manual sighting station is located in the GLOW facility building

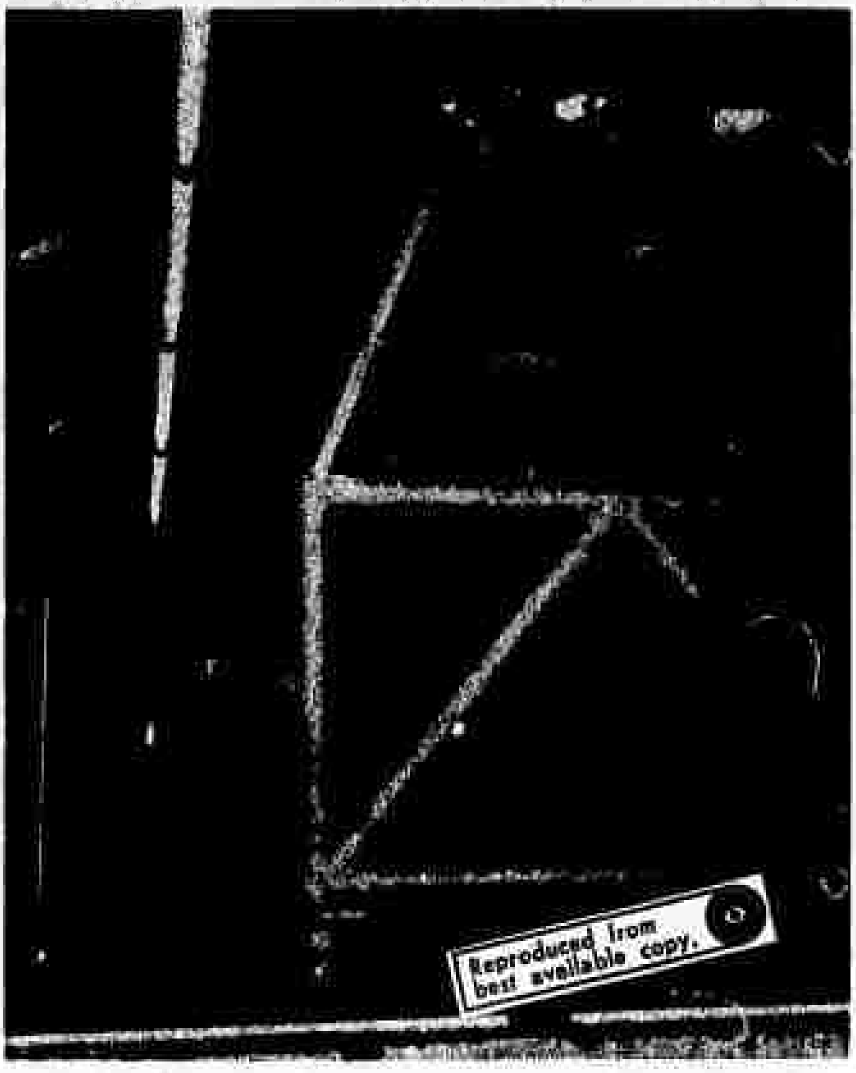


Figure 1-27. B-50 Manual Sighting Station Installation

Non-essential items, such as the gyros and the ranging device were removed. The 31-speed synchros were replaced by 25-speed units. This was accomplished through rework of the gear boxes to make the system compatible with the Nike-Ajax synchro system. A synchronizer, using solid state circuitry, was provided for automatic switching of the 25-speed and one-speed synchro transformer outputs. The reflex sight was reworked to provide an illuminated, variable intensity, collimated reticle display. A precision level was added to aid in leveling the unit, and the elevation axis payload was properly counterbalanced for easy operation. Viscous dampers were added to the azimuth and elevation axes to insure smooth tracking.

1.6.2 Darkroom

The darkroom (see figure 1-28) is located in the forward end of the utility van. Suitable cabinets, work space, ventilation, and water supply are contained within the room to allow development of photos and camera test films.

Figure 1-28. Darkroom

1.7 FREQUENCY CONVERTER UNIT

Power is supplied to the GLOW site from the range power lines. These lines are connected to a 30 kilowatt motor-generator set (see figure 1-29) which converts the 60-cycle AC range power to 400-cycle AC power for use in the GLOW site.

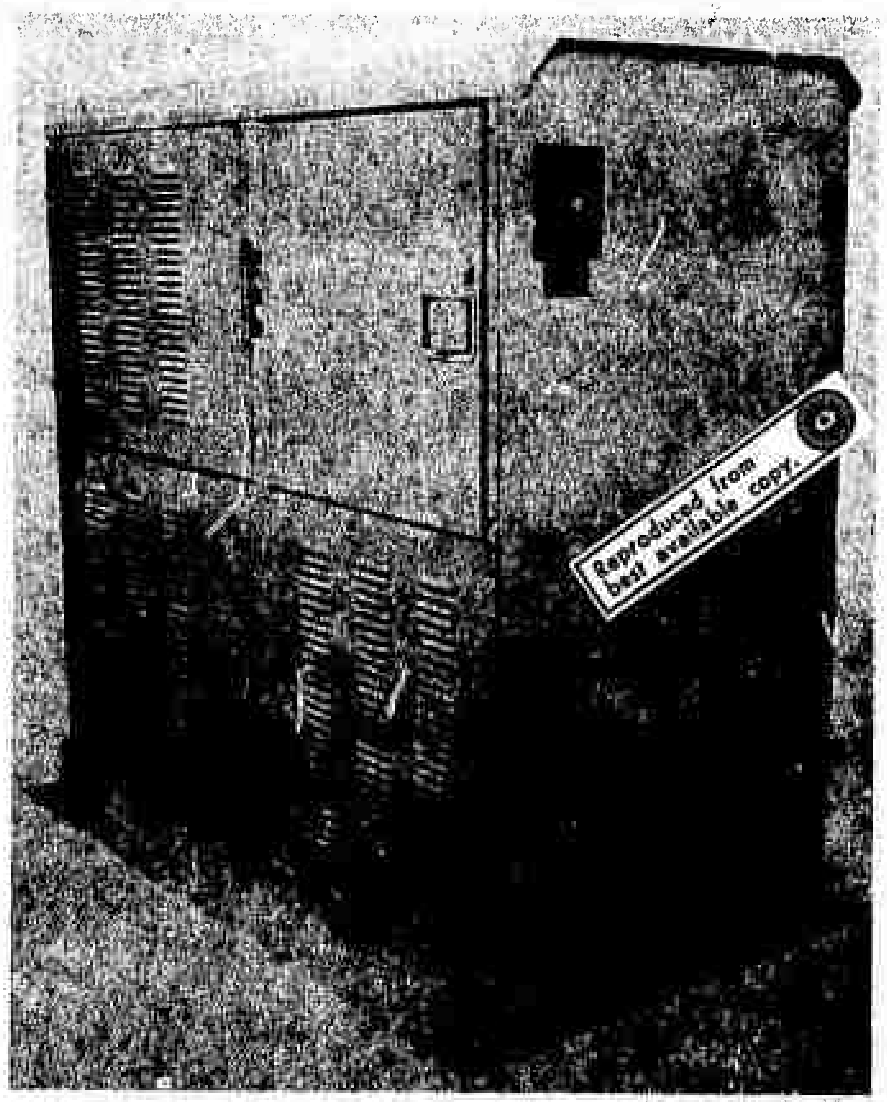


Figure 1-29. Frequency Converter Unit

SECTION II

SALINAS PEAK INSTALLATION

2.1 CONTRACT AIM

The Field Installation and Integration of one (1) GLOW System on the White Sands Missile Range was awarded to The Perkin-Elmer Corporation on 1 March 1965 under Contract No. DA-01-021-AMC-11992(Z). The stated aims of the contract were:

1. To install one (1) GLOW System on the White Sands Missile Range (WSMR), New Mexico.

2. To interface the GLOW System with the required facilities of WSMR.

3. To demonstrate GLOW System performance.

4. To provide on-site training of WSMR personnel in the routine operation and maintenance of the GLOW System. This training is not to interfere with the completion of the other three aims.

The object of this effort was to install and integrate the GLOW System at WSMR so as to demonstrate its capability as a ground based optical system to meet its primary objective, of measuring molecular and broadband radiations from a wide variety of reentry vehicles. A secondary objective of the GLOW System was to provide a platform for testing and evaluating experimental optical instruments such as those originated by Project GLINT. In addition, a crew of WSMR personnel was to be trained so that eventually they would operate and maintain the GLOW System.

Salinas Peak was chosen as the site for the GLOW effort after careful consideration was given to the following:

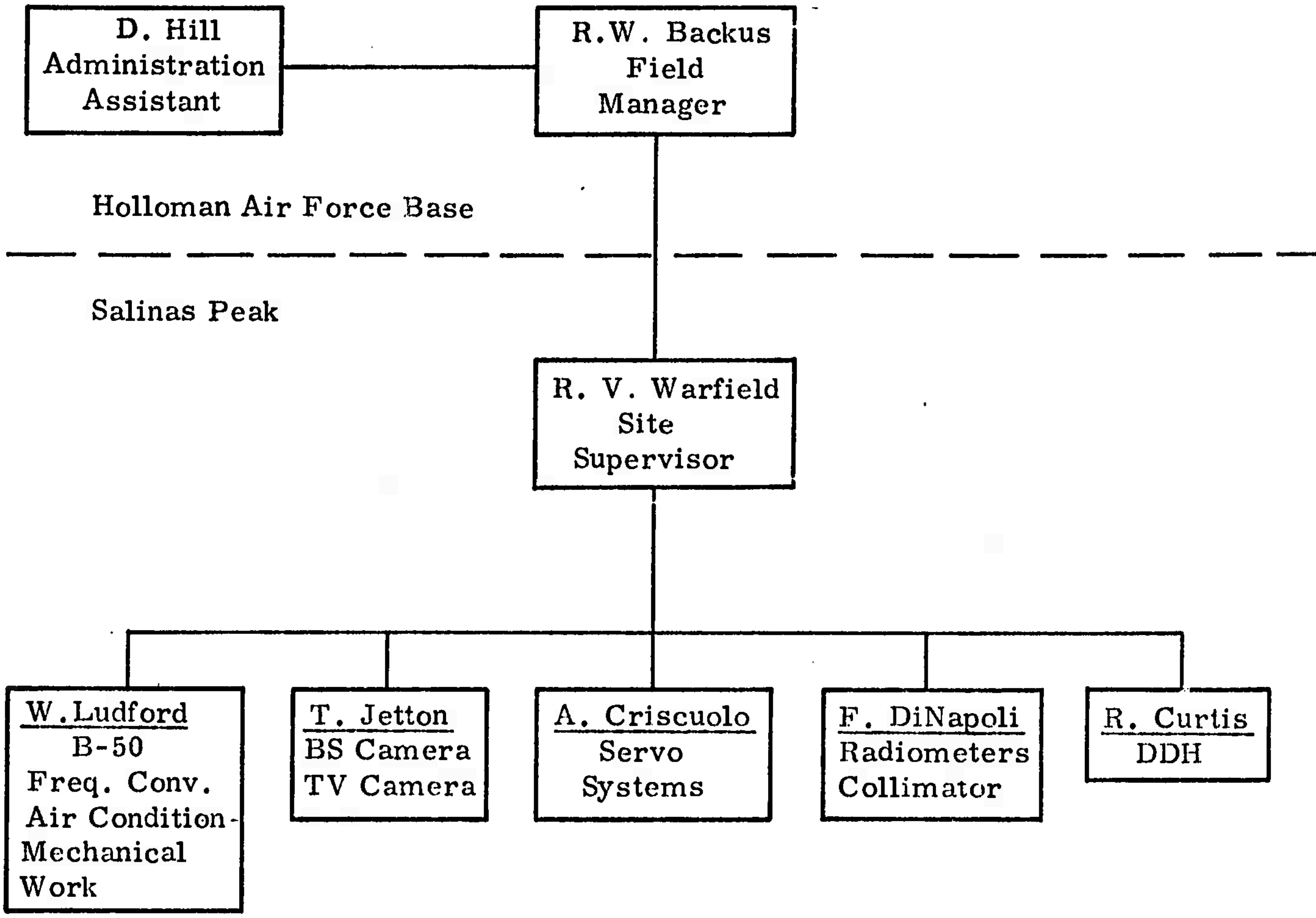
1. The site provided a good aspect angle for the proposed reentry trajectory.

2. The site was high above the dust of the valley.

3. Power was available at the site.

4. Roads were well maintained and made accessible the year-round.

The GLOW system field crew for the WSMR effort is depicted in the organizational chart.



WSMR GLOW System Organizational Chart

2.2 INSTALLATION

The Perkin-Elmer effort in the fulfillment of this contract encompassed the following tasks: Moving the No. 1 GLOW system and field crew from Norwalk, Connecticut, to White Sands Missile Range (WSMR); assisting WSMR personnel in moving the equipment to the 9,000 foot summit of Salinas Peak which was chosen by the U.S. Army Missile Command project engineer; installing the equipment at the peak; interfacing the equipment with range communication, timing, and precision acquisition system (PAS) data links; demonstrating performance to system specifications; and providing maintenance and operation of the equipment at Salinas Peak. Included also was the training of WSMR personnel, the integration of additional instruments, moving of the GLOW system to Sole site, the turn-over of the system to General Electric, and, finally, the assistance to General Electric in their first three months of operation.

2.2.1 GLOW Equipment Arrival at Stallion Range

The major units of the GLOW system arrived at the Stallion Range Center of the White Sands Missile Range by March 8, 1965 on a Government Bill of Lading. The equipment was received by Mr. J. Little of the U.S. Army Missile Command (AMICOM) and Mr. R. Warfield of the Perkin-Elmer Corporation. The entire Perkin-Elmer field crew arrived by March 12, 1965.

The GLOW mount was shipped from Norwalk, Connecticut to the Stallion Range Center of WSMR, New Mexico on a leased flatbed road trailer. The instrumentation van and utility van were transported from Norwalk to Stallion Range Center on their own wheel pulled by leased tractors.

Upon arrival at Stallion Range Center, the GLOW mount was transferred from the road trailer to a military flatbed trailer. The tractors were also changed to military vehicles at Stallion Range Center. The reason for these vehicle transfers was that the leased vehicles were not suitable for use on the range. Support equipment that was shipped secured in the aisles of the vans was removed and transferred to military four-wheel drive vehicles. Items that were not needed at the Salinas Peak site immediately were stored in a building at the Center. The GLOW mount, instrumentation and utility vans, and the vehicles carrying the support equipment then set out for the base camp near the bottom of the peak.

2.2.2 Transporting GLOW Equipment to Salinas Peak

Transporting the GLOW equipment from Stallion Range Center to Salinas Peak was handled by military and civilian personnel of WSMR under the direction of the Perkin-Elmer field crew. At base camp the GLOW mount was removed from the flatbed trailer and secured to a bulldozer and road grader for transportation up the steep grades with hairpin turns to the summit of Salinas Peak. The vans were also secured to the heavy duty equipment for transportation to the peak. Figure 2-1 depicts a section of the road up to Salinas Peak. An unintentional maneuver on any of the turns would easily have spelled disaster for the crew and equipment. The trip to the peak was accomplished on a call-ahead basis which required that a vehicle must request permission prior to ascending the 9,000 foot summit. This is basically a safety regulation to prevent a major accident on the difficult secondary roads. The GLOW equipment arrived at Salinas Peak without mishap on 10 March 1965.

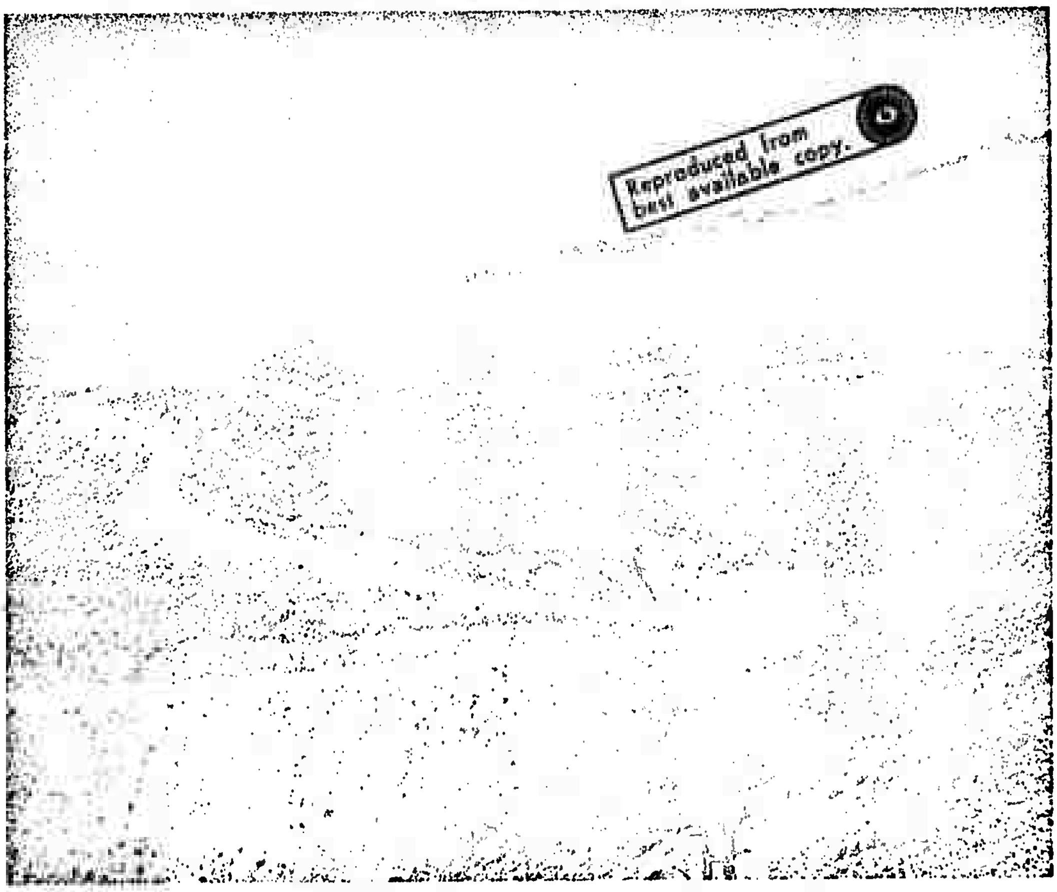


Figure 2-1. Hairpin Road to Salinas Peak, WSMR

2.2.3 Installation of GLOW Equipment on Salinas Peak

Upon arrival of the GLOW equipment on Salinas Peak, it was discovered that essestial items such as power and instrument pads were operational, so the installation was started immediately.

The installation began by spotting the instrumentation and utility vans, GLOW mount, target board, and calibration collimator. The equipment was then converted from the travel to the operational configuration. The equipment and sheds were secured with tie-downs because of the high winds on the peak. Interconnecting cables were laid and a grounding system was installed. Connections were then made to range power, timing, communications, and Precision Acquisition System (PAS) data lines.

After the major units were secured to the instrument pads, the task of installing the optical instruments (radiometers, vidicon, and boresight camera) on the GLOW mount instrumentation platform was initiated. The GLOW mount was then leveled and the instrumentation platform aligned. The instruments on the GLOW mount were boresighted and the encoders were set.

Many problems arose during the period of installation. Winds at the peak reached the vicinity of 100 mph. The high winds caused frequent downed power lines which resulted in power interruptions to the GLOW site. In addition, rain, sleet, dust, and snow provided hazardous working conditions. The emergency generators at the peak were not connected to the GLOW site because they had not been designed to carry this additional load. It was discovered that thin air at the peak (9,000 foot altitude) caused the men to tire rapidly when performing physical labor (i.e., laying system cables, rapid walking, etc.). It also contributed to component failure in the digital data handling system (DDH) because of decreased cooling.

2.2.4 GLOW Equipment Interface with Range

The interfacing of the GLOW System with the range consisted of interconnecting the equipment with the Salinas Peak microwave terminal equipment. (See figure 2-2.)

The range furnished the following technical support[1] to the GLOW site.

a) Timing signals (IRIG B) with an accuracy of ±5 microseconds, received by an Astrodata Time Code Translator/Generator (GFE).

(1) Operations Requirements No. 04502 Project GLOW WSMR, 12 April 1965.

b) A communications net to receive primary count-down information.

c) A real time data link from a 7094 Computer to provide look angles (AZ and EL) to the site. This was basically a precision acquisition system, 20 messages per second rate, but included two azimuth and two elevation commands in each message, which gave a command angle rate of 40 cps. The range work MR through LR only included the twelve (12) most significant bits of slant range.

After installation, the GLOW equipment was checked out using a recorded Kineplex message from an Ampex tape recorder. This Kineplex message was fed into the digital data handling system which in turn provided azimuth elevation pointing and trajectory information. This recorded Kineplex message was used as a basis for performing the evaluation tests.

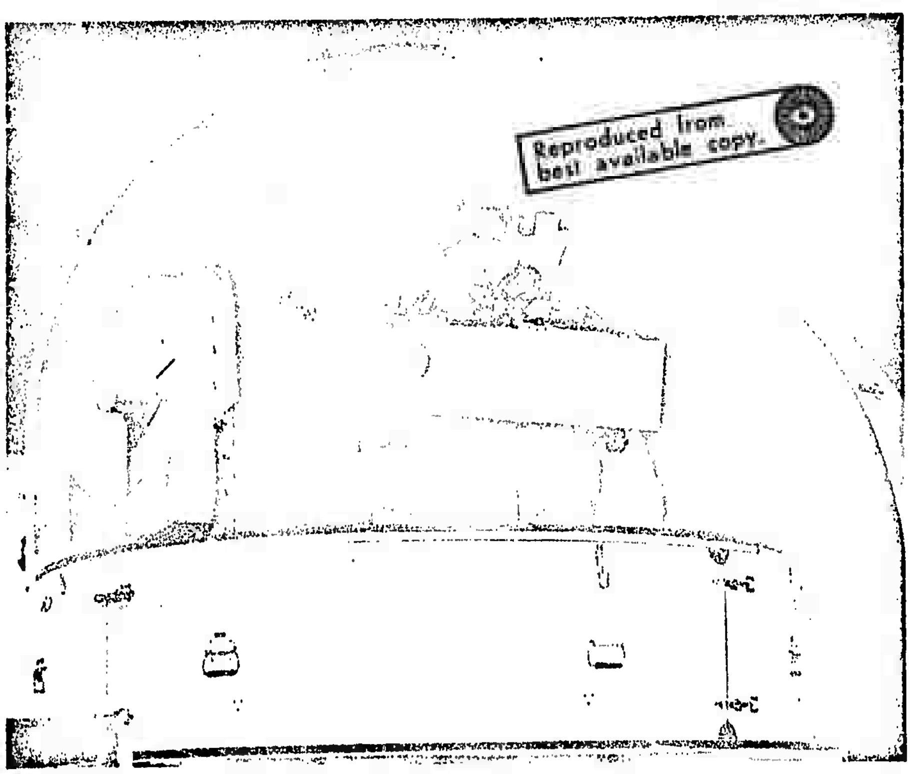


Figure 2-2. Perkin-Elmer Field Crew Working on Instrumentation Platform of GLOW Mount

2.2.5 Evaluation Tests

Evaluation tests were conducted on all systems to verify performance. The test results disclosed no degradation in performance of any of the systems. The results of the servo checks showed that the GLOW mount could handle any of the expected trajectories with less than one mil/rad error from pointing commands. For example: The radar loop Ka's were 330 for azimuth and 127 for the elevation axes. This would give a maximum tracking error of 0.090 for an acceleration as high as $30°/sec^2$ in azimuth and 0.24 in elevation while in the radar loop. Furthermore, it was also established that the radiometer calibration agreed with the results obtained in the tests performed at the Perkin-Elmer facility in Norwalk, Connecticut.

The GLOW system demonstrated its performance capabilities comparable to that existing during contractor's acceptance tests at Norwalk, and was accepted as operational by AMIC ON on 26 April 1965. The achievement is noteworthy: This is seven weeks after the equipment arrived at Salinas Peak and one week ahead of schedule.

2.3 OPERATION

2.3.1 General

With the acceptance of the GLOW site on 26 April 1965, field activities now moved into the operational phase. The work effort performed at Salinas Peak during this period was composed of four main categories:

1. The operation of equipment on Athena missions No. 013 through 035.

2. The integration of new equipment into the system.

3. Maintenance and improvement of site and equipment.

4. Preparation for move from Salinas Peak to Sole Site.

The operation of the GLOW system on Salinas Peak supported twenty-three Athena missions. The results obtained proved the GLOW system to be highly accurate and reliable optical tracking equipment. It demonstrated the high degree of proficiency of the field crew and the validity of the Perkin-Elmer pre-flight operational checkout and count-down procedures. The GLOW equipment was operational for every Athena mission; no data was lost because of a malfunction of the GLOW system.

2.3.2 Development of Checkout and Count-down Procedures

After the initial installation of the GLOW system at Salinas Peak, a Pre-Flight Operational Checkout Procedure was developed. This checkout procedure required a detailed step-by-step inspection, adjustment, alignment, and calibration of all components in the GLOW System, and was always performed the day prior to a test flight. To ascertain that all systems are GO at lift-off, a count-down procedure was developed, which was performed during the launch count-down on the day of the test flight.

The checkout and count-down procedures were developed while performing training exercises with Aviac balloons and Hibex missiles. Although the balloons and Hibex missiles were too small to be picked up by the GLOW equipment, they did provide valuable training for the field crew.

The checkout for the GLOW System also included frequent boresighting with the star Polaris.

2.3.3 Athena Missions

The primary test objectives of the GLOW system during the Athena test flights were to record optical signature data during payload reentry and to verify performance of the GLOW instruments and acquisition systems.

A regional map of WSMR showing the missile trajectory to the point of impact is shown in figure 2-3.

A typical Athena Mission (test flight No. 030, for example) is performed as follows: The GLOW field crew would perform a pre-flight operational check-out procedure the day prior to the flight. On the day of the flight, the station would open approximately twelve hours before lift-off. These would be a local communications check between the GLOW equipment. The 35mm bore-sight camera would be checked for proper operation. A communication check would then be made with the range and a test would be run on the Kineplex data link to check for satisfactory message content. The radiometers would be calibrated; then the system would begin its count-down procedure.

The missile for Athena Flight No. 030 was launched from the Green River Launch Complex. The trajectory was a high angle reentry. Lift-off was at 23:33:31 MST; inclement weather with 60 mph winds made tracking difficult. At plus 351.096 seconds, the DDH recorders were started and radiometer data was recorded during payload reentry. Images also appeared on the vidicon television system and on the film from the boresight camera.

Tracking was in the radar mode. The acquisition and recording sequence chart in figure 2-4 indicates the periods of data acquisition, tracking modes used and range and/or altitude of the reentry vehicle throughout the mission trajectories. Athena Flight No. 30 is summarized as follows:

Event	Seconds After Lift-off
Second Stage Ignition	46.998
Third Stage Ignition	356.408
Third Stage Burnout	379.948
P/L Separation	387.848
Retro Ignition	390.998
Payload Reentry	402.9

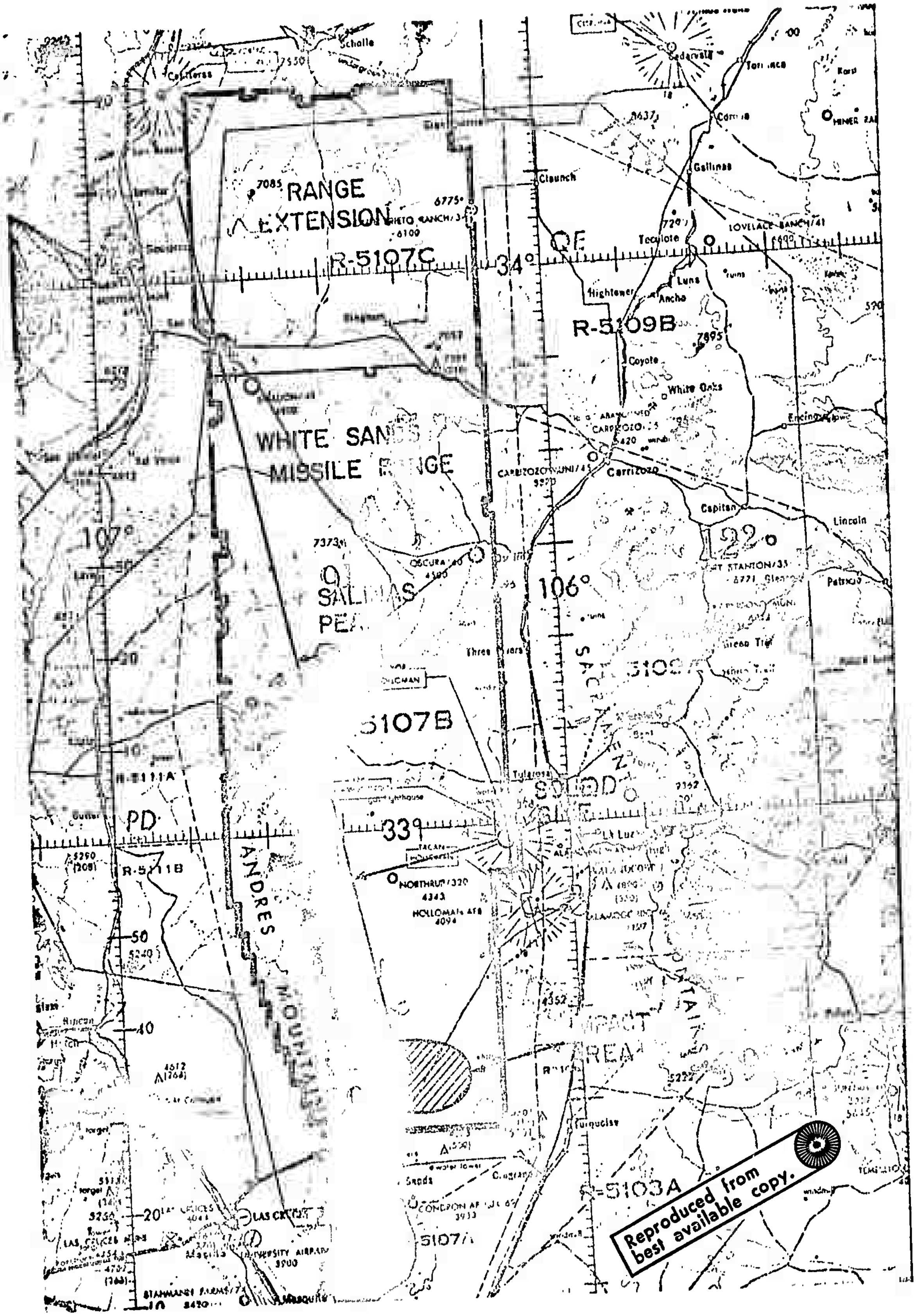


Figure 2-3. White Sands Missile Range

Visicorder charts indicated that the radiometer signals compared with signals recorded on digital tape. The pre and post calibration runs made on channels 1 and 2 of both radiometers were excellent. No indication of radio frequency interference was noted.

Kineplex data was recorded by the communication recorder for playback as interim trajectory retrace. Boresight camera, visicorder, and digital recorders were started at +350 seconds, 6 seconds prior to third stage ignition.

The mount was in the radar slave mode at the start of the test. Shortly before ignition of the third stage, an abrupt shift in command data was noted. The third stage, fourth stage, and retro were observed by the sighting station. operator about 15° from the command angles. No staging was seen on TV. When no acquisition was made, the mount was switched to sighting station mode at +435. In this mode, sightings of the payload were made. Continuous data from all radiometer channels were recorded; intermittent data were recorded by the boresight camera.

Data were recorded as follows:

Boresight Camera

4 frames	LO + 436
16 frames	LO + 436.5
7 frames	LO + 437.6
3 frames	LO + 438.15

Radiometer

Rad A, Ch 1	1.2 sec at LO + 436
Rad A, Ch 2	0.8 sec at LO + 436.4
Rad B, Ch 1	0.8 sec at LO + 436.4
Rad B, Ch 2	0.8 sec at LO + 436.4

Instrument settings and recording data were as follows:

Instrument	Item	Setting of Parameter
Boresight Camera	Film	Kodak 2475 ASA 1250
	Exposure	1/200 sec
	Frame Rate	20 FPS
	Shutter	35°
	Field of View	1° x 1.3°, see figure 2-5

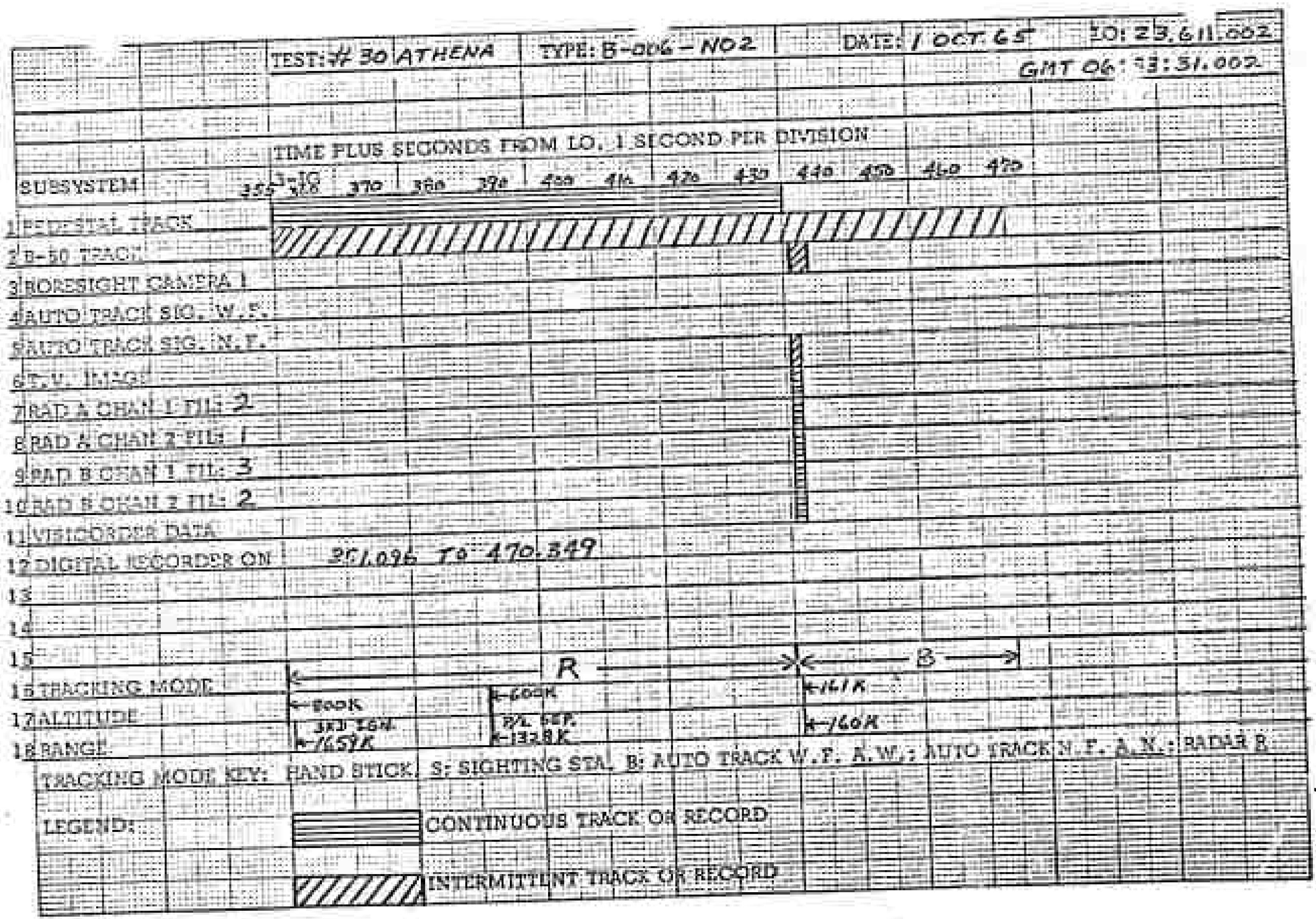


Figure 2-4. Acquisition and Recording Sequence

Instrument	Item	Setting or Parameter
Radiometer	Field of View	4 x 4 mrad
Rad A1	Filter	No. 2 1.45-1.7 microns
Rad A2	Filter	No. 1 3.25-3.8 microns
Rad B1	Filter	No. 3 2.0-2.5 microns
Rad B2	Filter	No. 2 3.75-4.4 microns

The following is an explanation of the Acquisition and Recording Sequence chart:

Item #1

On-track indication is based on 3 mrad error between command data and position data. No presumptions are made as to the accuracy of the command data.

Item #2

The B-50 manual sighting station is principally shown as having intermittent track. This is because the target was visually erratic and difficult to track at higher velocities.

Item #3

On-track indication for the boresight camera is any image on the frame, even though the target may be out of the field of other instruments.

Item #4 and #5

Positive signal plot is any indication of signal increase due to target. In some cases, the signal is too weak to track; in other cases, the target was not payload and, therefore, ignored.

Item #6

Self-explanatory.

Items #7, 8, 9, 10 and 11

Positive signal plot is any indication of signal increase due to target.

Item #16

Shows tracking mode for complete trajectory without regard for on-track indications.

Item #17

Altitude at key events.

Item #18

Range from GLOW site at key events converted from trajectory data.

After each mission the GLOW mount would be slued to its starting position and the mission would be rerun from a recording made on an Ampex tape recorder. This would allow comparing radiometer measurements of a star filled sky without the reentry vehicle to the original measurements taken with the reentry vehicle and boosters.

At the completion of each mission, one of the tapes from the DDH equipment is stored and the other is re-recorded in the IBM format. This tape, together with the film from the boresight camera, is then sent to the Athena Mission Team at Holloman Air Force Base for data reduction. Appendix C is a GLOW quick look report, typical of those issued after each mission.

2.3.4 Integration and Checkout of New Equipment

The integration and checkout of new equipment into the GLOW system was one of the test program objectives. Because of the high inherent accuracy of the instrumentation platform on the GLOW mount, selected line, band, and continuum radiation characteristics would further the understanding of reentry physics, verify present theoretical optical equipment, aid in the development of new optical equipment, and study the scaling effects of vehicles. These measurements would also establish or disprove the need for specific tests.

In addition to integrating new equipment, there were modifications to two existing systems in the field. These systems were the B-50 manual sighting station and the trajectory retrace system.

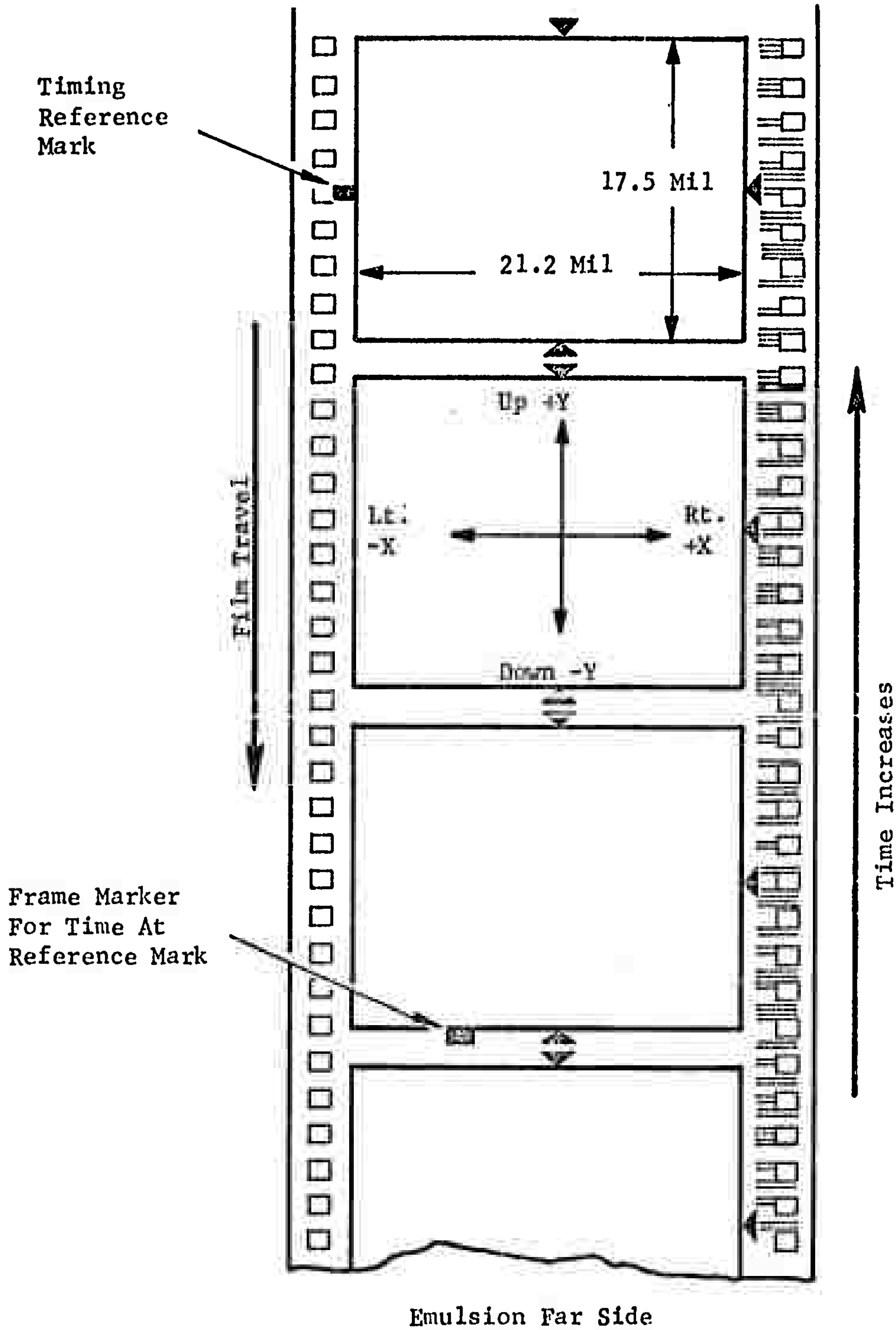


Figure 2-5. GLOW Boresight Film Orientation and Markers

2.3.4.1 Mithras Infrared Autotracker

On 24 May 1965, the Perkin-Elmer field crew, assisted by the Mithras representatives, began the installation and intergration of the infrared autotracker.

Preliminary operation of the autotracker indicated technical design deficiencies which could not be tolerated in an instrument functioning as the prime acquisition tracker for the GLOW system.

An evaluation program was initiated at the Salinas Peak installation and continued at Sole Site and on the second system at Perkin-Elmer in Norwalk, Connecticut.

Analysis of the evaluation data concluded that the Mithras autotracker was inconsistant in performance, unreliable in operation (failure of numerous subassembilies), required frequent adjustment and balancing, suffered from a significant temporal variation in recorded transfer function, and possessed a limited closed loop track field.

Perkin-Elmer therefore recommended that the Mithras autotracker be removed from the GLOW System and be replaced by a more reliable, field operable, autotracker. The following options were proposed:

1. Acquisition of available surplus trackers (Barns, trackers used on GLINT).

2. Complete redesign of the Mithras autotracker.

3. Complete disassembly of the autotracker to allow use of the main castings and optics. An image dissector tube or other type of applicable tracking system could be substituted.

4. Continued development of the AMICON four quadrant reticle tracker (Perkin-Elmer)

The evaluation program and analysis are summarized in Report No. 8441A by Perkin-Elmer. This report is reproduced in Appendix B.

2.3.4.2 Intergration of the Dalmo-Victor AC Radiometer

Interfacing of the Dalmo-Victor AC radiometer on the GLOW System was initiated in late June and completed by July 7, 1966.

Integration tasks consisted of internal instrumentation van wiring to accept the Dalmo-Victor electronic and recording chassis, platform mounting of the instrument, rebalancing the pedestal, and equipment checkout.

Members of the Dalmo-Victor staff assisted in all phases of the interface and their cooperation made possible the completion of the task with a minimum of difficulties and time.

2.3.4.3 B-50 Sighting Station Field Modification

The B-50 field modification consisted of the integration of a visual null indicator (VN 1) package which is used in place of the retiflector sight.

The VN 1 package consists of a 7 x 50 binocular and an electro-optical component which contains a cathode ray tube, illuminated reticle, and two mode indicating lamps.

The tube displays a pointing error signal generated by comparison of the position of the sighting station as compared to the position of the remote radar system which is tracking the target. An error signal generated by comparison of the position of the sighting station as compared to the GLOW mount is also displayed on the tube. By nulling this error signal, the sighting station operator is pointed at the target depicted by the radar system. The mode indicating light informs the sighting station operator as to which mode of tracking is being used, i.e., the radar or the manual sighting station. The addition of this VN 1 package required modifying the B-50 control console to provide operating power to the VN 1. Amplification and switching logic circuits were also added to the B-50 control console.

In addition to the VN1 integration, adjustable dampers were installed on the azimuth and elevation axes of the B-50 sighting station. The purpose of the adjustable dampers is to introduce a slight drag in the azimuth and elevation axes to permit improved tracking.

2.3.4.4 Trajectory Retrace Modification

The purpose of the trajectory retrace modification is to provide a means of recording the signature background noise level of the exact path that a reentry vehicle has taken.

The modification consists of a logic case and magnetic tape recorder. During a mission while a reentry vehicle is tracked, azimuth and elevation positions from the digital shaft encoders on the GLOW mount are recorded on magnetic

tape. After vehicle impact, the system is switched into the retrace mode by the console director and the recorded azimuth and elevation positions are reproduced by the magnetic tape handler. The reproduced data then becomes the retrace command angles, which are transferred to the DDH system for processing and generating error signal to the servo system.

The magnetic tape recorder has 14 record/reproduce channels. Five channels are required for trajectory retrace, the other nine channels can be used for recording instrument data during preflight, mission, retrace and/or postflight recording modes. This data can be reproduced off line and recorded on the visicorder for additional quick-look capability.

Range time is recorded on the magnetic tape recorder during the Mission Record mode. In Retrace mode, range time is reproduced to drive the Time Code Generator. This is required for background data correlation.

2.3.5 Training of WSMR Personnel

The training period of WSMR personnel began in June 1965 and lasted through September of the same year. The training programs were divided into three periods. During the June-July period there were two trainees, the July-August period had three trainees, and the August-September period had five trainees. The training program involved instructions in the operation and maintenance of the GLOW system.

The primary problems with the training program involved the time element. Due to the inability of the WSMR people to devote only 6 hours daily, 4 days a week on the site, the training program was not as successful as it could have been.

Nighttime training in equipment calibration and boresighting was offered with no positive response from the trainers.

The training program was ill-timed since it was in direct conflict with the integration program and the concurrent Athena mission support.

The end result was to abort the training program.

SECTION III

SOLE SITE INSTALLATION

3.1 SITE SELECTION

During the operational phase of the GLOW System, it became apparent that consistent acquisition of the Athena reentry vehicle (R/V) would be difficult to achieve at the Salinas Peak Site.

The following conditions were considered intolerable:

1. The high angle shots reentered almost directly overhead (elevation angles to 80 degrees) resulting in high angular tracking rates in excess of 30 degrees/second.

2. The high aspect angle resulted in the GLOW instrumentation seeing the R/V throug the plume and Athena tankage.

The decision was made to relocate the GLOW system to an area that would eliminate the above problems.

After deliberation of seven sites (see figure 3-1 and table 3-1), Tully Peak was considered the first choice for relocation. This site, however, was unavailable, and therefore the second choice (Sole Site) was selected for the GLOW System.

It's location afforded an excellent nose and side aspect angle and it's proximity to the Holloman Air Force Complex and Alamogords living facilities had distinct advantages.

It's major disadvantages (high dust area and lack of adequate electrical power) were considered secondary.

Power was provided by a rented 250 KVA, 60 cycle, commercial, deisel generator and the dust was reduced with rock graveling of the immediate area.

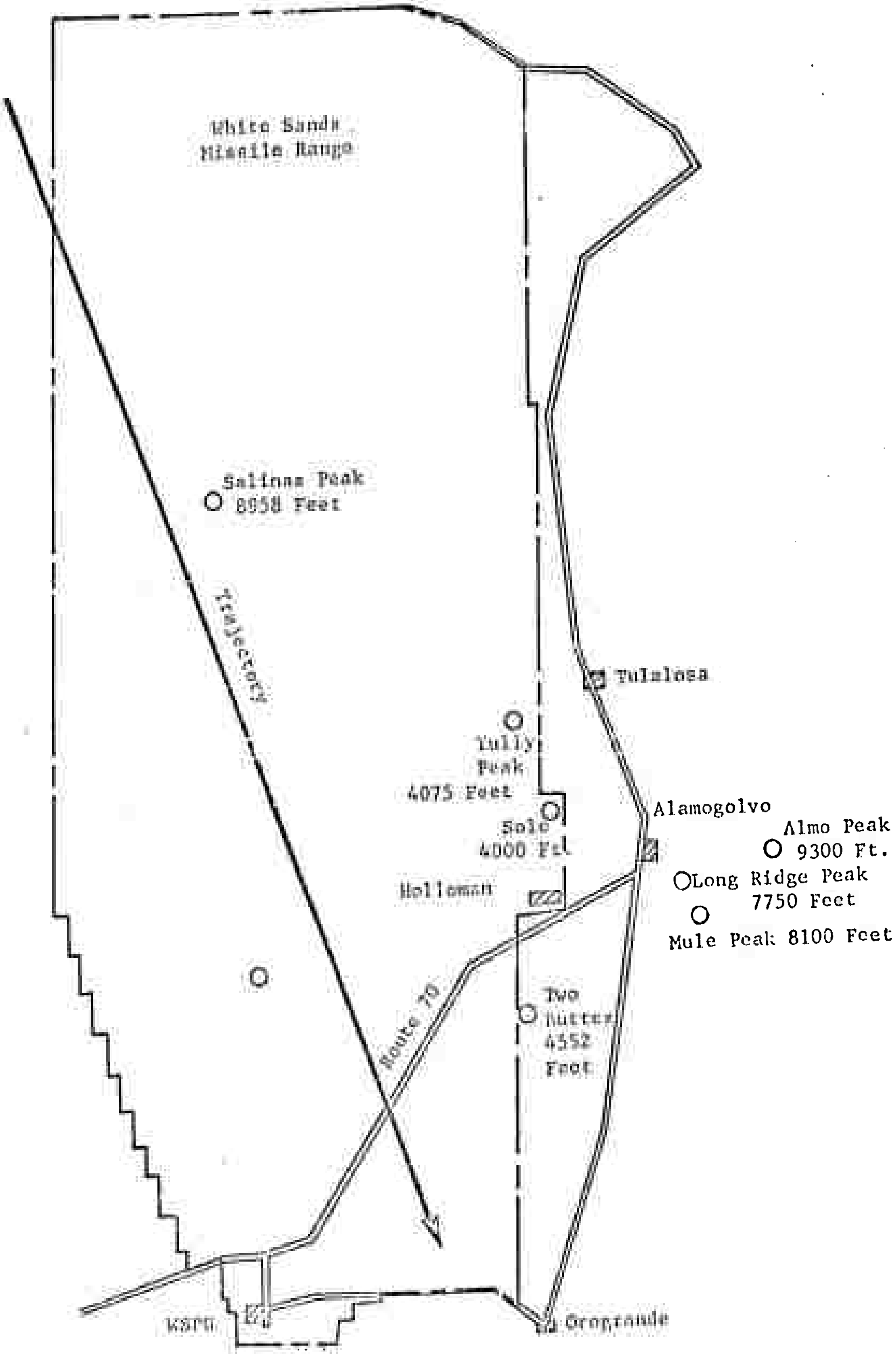


Figure 3-1. Site Locations

TABLE 3-1. SITE SURVEY

DESIRABILITY	TULLY PEAK	MULE PEAK	LONG RIDGE PEAK	ALMO PEAK	SEEHORN	TWO BUTTES	SOLE
Aspect Angle	Nose and side aspect: excellent.	Nose and side aspect: excellent.	Nose and side aspect: excellent.	Nose and side aspect: good. (However, further back in mountains than Long Ridge and Mule.)	Nose only. Side at fly-by only.	Nose and side aspect: excellent.	Nose and side aspect: excellent.
Field of View (FOV)	No obstructions.	Excellent.	Minor obstruction with telemetry. Otherwise good with minor pruning of shrubs	Unobstructed.	Unobstructed. Slightly above desert floor.	Unobstructed.	Unobstructed.
Communications	Land line. No microwave.	No communications. Wires visible. Two communication towers in place.	Communication and microwave links exist.	Not obvious. Microwave link exists.	Land line. Kineplex available.	Available	Available. (Appears to be temporary installation.)
Power	4 wire, 208 v, 3ϕ, 100 kva, commercial.	4 wire, 208 v, 3ϕ, 2 diesel generators (45 kva each) in generator building	3 wire, 220 v, single phase	4 wire, 208 v, 3ϕ, 60 kva, commercial power generator building available (now empty).	120/208 v, 3ϕ, 60 kw. Can be expanded	Available	220 v, single ϕ. (Appears [illegible] temporary installation.)
Accessibility	Excellent.	Fair. Vans can negotiate curves and hills.	Fair. Vans can negotiate curves and hills.	Excellent, but vans must be "spotted" one at a time on peak.	Excellent.	Fair. Dirt road off limits [illegible] to peak [illegible]	Excellent. Dirt road on desert floor.
Road Conditions	Hardtop all the way to the peak.	19 miles of dirt road. State maintained. Said to be kept open in winter.	19 miles of dirt road. State maintained. Said to be kept open in winter.	Hardtop all the way to the peak from Cloudcroft.	Hardtop all the way. About 1 hour ride from Alamogordo.	Impassible here to peak. Vans cannot maneuver.	Good. Dirt road off range road
Water Supply	Available.	Well.	None.	None. Must be supplied to 200 gallon storage.	None.	None.	None.
Fuel Supply	Available.	Available.	Available.	Available.	None.	None.	None.
Storage Facility	None. Present vans must be used.	20' x 20' building.	None.	Quonset hut. Microwave equipment building (not in use).	None.	None.	None.
Living Quarters	None.	25' x 50' cement block building. Living room bed-rooms, kitchen, and bath.	None.	Part of microwave building: shelving, sink, and hot water heater.	None.	None.	None.
Site Preparation	Very little. Vans can be "spotted" in parking area.	Remove telescope now mounted in optical building.	Land clearing required: bulldozing flat spot for system.	Very little. Two concrete pads for vans. Three concrete piers for GLOW.	None.	None. No space available. Impossible to increase area.	Crushed stone around area necessary to eliminate severe dust problem.
Miscellaneous	1. Mount could be located on roof of existing building. 2. Present telemetry personnel will object strongly to installation.	1. No Kineplex link. 2. Helicopter pad. 3. Old "ROTI" type optical building. (Slides on rails.)	1. Helicopter pad. 2. Microwave link exists. 3. Approximately 1 1/2 hour ride from Alamogordo. 4. Orogrande visible to south. 5. Commercial TV repeater station on peak.	1. Four concrete radar piers outside of Quonset hut. 2. Instrumentation van pad. Cable raceways to mount pad. Tie downs. 3. "Do Vap" van now on pad. 4. Weather may be problem.	1. Plenty of room for vans. 2. "Igor" and "Dits" system now operational on site. Have been tracking Athena shots. Have problems getting data due to high angle and fly-by. Data obtained about 10% of time.	1. High RFI field due to rampart AMRAD radars located south of peak. 2. New equipment now scheduled for peak: ballistic cameras, cine mounts. 3. Road extremely hazardous.	1. High dust area 2. Radiant heat from desert might affect radiometers. 3. Boresight problems due to shimmer.

3.2 SYSTEM RELOCATION TO SOLE SITE

In early January, 1966, the preparation for the relocation to Sole Site began, with the scheduling responsibility for completion assigned to General Electric. On January 17, 1966, the system was shut down and Perkin-Elmer initiated preparations for moving the system to Sole Site, 80 miles away.

A severe winter storm during the tear down period at Salinas Peak seriously hindered the relocation effort. Power and communications were out, eliminating light, heat, and use of power equipment during the dismantling phase. High winds and near zero temperatures with large accumulations of snow and ice on the Salinas access road and the GLOW site area, made work and travel very difficult, and at times, quite hazardous.

A shortage of personnel in the WSMR transportation and maintenance section placed additional work on the Perkin-Elmer field crew.

One of the GLOW System engineers secured a WSMR driver's permit and, using a van furnished by WSMR, hauled most of the peripheral equipment and instruments to temporary storage near Sole Site.

The three semi-trailer vans were removed from the peak by tractors and drivers furnished by the WSMR transportation section. The balance of the system was removed on flatbed trailers and open stake trucks furnished by WSMR.

Because of inclement weather and icy or muddy roads, two days were required to transport the major equipment to Sole. Transfer of all the GLOW equipment was accomplished within two weeks after the final preparation tasks were completed.

3.3 INSTALLATION AT SOLE SITE

Arrival of the GLOW System at Sole Site pre-dated completion of the site preparation by approximately one week. Installation efforts began before adequate power was available and while the contractor was finishing concrete work and spreading gravel around the area for dust control.

The system installation was completed and checkout of the system began. As expected, a number of equipment malfunctions attributable to the physical move occurred. In addition, several malfunctions were caused by the extremely dusty environment of Sole Site such as:

1. Severe dust accumulation on the calibration collimator precision railbed and drive mechanism.
2. Failure of the motor generator relays and exciter brushes in the frequency converter.
3. Severe daily accumulation of tracked-in dust in the instrumentation areas of the van.

The interface with range timing, communications, and Kineplex required the installation of additional land lines (supplement to the existing ones). Participation in frequent "Real Time Data System" tests with the Holloman Center were required before the proper signal levels and Kineplex message content were useable.

3.4 INTEGRATION OF G.E. IMAGE ORTHICON

After completion of the major installation tasks, Perkin-Elmer began the job of integrating the G.E. image orthicon TV system.

This job included fabrication and installation of cables and wiring for interfacing the image orthicon TV camera assembly and two racks of equipment. One equipment rack contained a visual timing display, two "A" scopes which provide a magnified display of selected portions of the image orthicon video output, a kinescope which displays the total I/O field of view, and a camera for film recording of these displays. This rack also contains control circuitry for the I/O camera system.

The second rack is an operation console containing the Bendix circuitry and a monitor kinescope. Most variable I/O camera functions are controlled from this console. The rack also contains controls for the Bendix tracking gates.

Wiring and coaxial relays were installed for switching the GLOW servo system to the I/O tracker mode and for recording various functions of the I/O system on magnetic tape. After installation and boresight of the I/O system was made, evaluation of the system began. Several problems were encountered during the checkout and evaluation. Problems occurred with some I/O control circuits, incorrect Bendix tracking gate output and malfunction of the timing display. Assistance required by the G.E. engineer in correcting these problems was provided by the Perkin-Elmer field crew.

Although some problems existed with the Bendix tracking gates which would not be corrected immediately, it was felt that the I/O system would aid immeasurably in identifying, acquiring, and tracking an Athena payload.

3.5 INTEGRATION OF GLOW JITTER PACKAGE

To preface our next task, mention should be made that accelerometers and rate gyros had been added to the GLOW System as the primary sensors to detect random instrumentation pedestal motion when various instrument loads or different tracking schemes are employed. These sensors are precision devices that can measure high frequency (greater than 1 cps) motion with an accuracy of one part in 10^6.

The jitter package consists of an instrument box and a control chassis. The instrument box, containing two accelerometers and two rate gyros, was installed on the instrumentation pedestal. To facilitate access to the rate gyros for proper axis positioning, the instrument box cover is removable. The control chassis, containing the signal processing circuits that are associated with the sensors, was mounted in a rack below the operator's console.

A gyro and accelerometer pair was assigned to the azimuth axis and a pair was assigned to the elevation axis. The two accelerometers were then permanently mounted to the pedestal; each secured through the thin aluminum frame of the instrument box to an extremely rigid mounting plate. The mounting plate for each accelerometer was then bolted to the instrumentation pedestal.

The two rate gyros, each contained in a cylindrical housing, are supported on individually adjustable mounts. Each housing is scored to facilitate proper positioning and orientation on the instrumentation pedestal. Both gyros were secured through the thin aluminum frame of the instrument box to an extremely rigid mounting plate. The mounting plate was then bolted to the instrumentation pedestal.. Once secured in place, the gyro mounts were adjusted to orient the devices parallel to their respective axis (azimuth and elevation).

The control chassis was installed in a standard 19-inch relay rackframe and was secured in place. Power and signal connections were made through connectors on the rear of the chassis and into the rear of the operator's console.

3.6 SUMMARY - INSTALLATION

Integration of the General Electric image orthicon and Bendix tracking gate system, installation of the GLOW jitter package, system equipment evaluation and preparation for system transfer to General Electric on April 1, 1966, required a full time effort during March.

The Sole Site installation concluded with the participation in two Athena missions on March 31, 1966. The primary objective for our participation was as a training exercise for the General Electric personnel.

All equipment was functional. The newly installed image orthicon TV system was a marked improvement over the vidicon TV system. With the planned installation of a wider field of view, this I/O system should increase the tracking capabilities of the GLOW System.

3.7 SYSTEM TRANSFER

On April 1, 1966, the transfer of the GLOW System was turned over to The General Electric Corporation. A preparatory four-week training program was started on February 17, 1966 at Perkin-Elmer's facility in Norwalk, Connecticut. The training program was attended by General Electric field and engineering personnel.

In order to provide further assistance during the critical turnover period, two Perkin-Elmer technical representatives were contractually requested to remain at WSMR. Their responsibility was primarily in an advisory role on system maintenance, operation, and familarization with documentation and wiring.

The following summarizes the major efforts of the extended support:

1. Provided system knowledge in order to guide General Electric through troubleshooting sessions.

2. Guided General Electric through preparation procedures for a mission.

3. Resolved the difference between malfunction of the equipment and operator error.

4. Real-time loop tests were conducted frequently. DDH (digital data handling) equipment and the servo system performed excellently.

5. Provided detailed instructions in cryogenics loading, collimating procedures, radiometer operation, and analog recorder setups.

6. Checked the boresight on all of the instruments.

7. Conducted troubleshooting of the radar servo loop.

8. Assisted in corrective maintenance on the B-50 synchro alignment.

9. Updated blueprints.

With the departure of the two technical advisors from Sole site, on June 30, 1966, Perkin-Elmers' participation in Project GLOW concentrated on the preparation of GLOW System II for installation at the Kwajalein Test Site, Marshall Trust Territory in the central Pacific.

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ABBREVIATIONS

A/D	Analog-to-Digital
AGC	Automatic Gain Control
AMICOM	United States Army Missile Command
BLIP	Background Limited Infrared Photodetector
BOR	Beginning-of-Record
BTU	British Thermal Unit
COBI	Coded Biphase
CRO	Cathode Ray Oscilloscope
D/A	Digital-to-Analog
DBM	Unit of Measurement; 1 mw into 600 ohms
DCR	Dual Channel Recorder
DDH(s)	Digital Data Handling (System)
DDR	Data Digitizing and Recording
DR	Discrimination Radar
EFL	Effective Focal Length
EOM	End-of-Message
EOR	End-of-Record
EOS	End-of-Sampling
ERM	Electro-Magnetic Radiation

FOV	Field-of-View
GBL	Government Bill of Lading
ICC	Interstate Commerce Commission
IO	Image Orthicon
InSb	Indium Antimonide
IRIG-B	Time Code, type
LFOV	Large Field-of-View
LO	Lift-Off
MGC	Manual GAIN Control
mrad	Milliradian
NEPD	Noise Equivalent Power Density
PAS	Precision Acquisition System
PbS	Lead Sulphide
RFD	Rotating Field Detector
RFI	Radio Frequency Interference
ROTI	Recording Optical Tracking Instrument
RTDL	Real-Time Data Link
RTDS	Real-Time Data System
R/V	Reentry Vehicle
SFOV	Small Field-of-View
TD	Tracking Data
VNI	Visual Null Indicator
WSMR	White Sands Missile Range